LEPROSY

DIAGNOSIS, TREATMENT AND PREVENTION

(Sixth Edition)

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LEPROSY—DIAGNOSIS TREATMENT AND PREVENTION

PREFACE TO THE SIXTH EDITION

This book is issued by the Indian Council of the British Empire Leprosy Relief Association primarily for the use of doctors in India who wish to be put in touch with practical means of dealing with leprosy from both the therapeutic and the public health points of view It is hoped that it will also prove useful in the British Colonies and in other countries where leprosy is endemic

Much of the teaching found in standard text books has been omitted in order to make it possible to condense within a few pages knowledge that is absolutely essential for understanding the nature of the disease and the lines along which it may be dealt with successfully

Since the fifth edition was published considerable advances have been made in our knowledge of leprosy Many statements appearing in that edition need revision in the light of more recent research and clinical experience

The whole work has therefore been rewritten and sections on history endemiology and bacteriology added In studying skin and nerve leprosy the clinical and histological features have been dealt with conjointly as in every type and sub type of leprosy each of these features throws light on the other The histological findings are based on a study of biopsy material taken from the different clinical types

As is indicated in the title the book is divided into three parts The first deals with the nature of the disease from the historical etiological bacteriological pathological and clinical aspects These lead up to *diagnosis* which includes not only the recognition of the disease itself but seeks to make plain the methods of ascertaining the type and—that all important factor in each case—the resistance of the patient to the infection

The second part is devoted to *treatment* both in its general and special aspects and a chapter is added on prognosis

In the third part *prophylaxis* is discussed The preventive aspects of leprosy have assumed a much more important position in the last few years and this is discussed at much greater length than in the former editions

Leprosy is one of the most difficult problems with which the medical profession is faced This volume seeks to explain leprosy as far as it is at present understood and to lay down certain principles which if followed out intelligently and energetically should in the end help towards ultimate control

I wish to express my indebtedness to Dr John Lowe of the Indian Council of the British Empire Leprosy Relief Association for help in correcting the text and preparing illustrations

Part One

INCLUDING HISTORY AND ENDEMIOLOGY, BACTERIOLOGY, CLINICAL AND HISTOLOGICAL FEATURES, AND DIAGNOSIS

CHAPTER I

History and Epidemiology

(1) *History of Leprosy*

Some writers have placed the original home of leprosy in Asia others in Africa The earliest accounts are from Egypt where it was introduced in 1350 B C by negro slaves from the Soudan and from India where its existence is mentioned in the Vedas about 1400 B C

Leprosy appears to have been brought to Eastern Europe first by the Persian armies Later Roman soldiers who had taken part in eastern campaigns introduced it first into Italy and then into other European countries It was spread still further by the Saracen invaders of Spain and by crusaders who had wandered in endemic countries Pilgrims returning from the East are also supposed to have helped in the dissemination

Leprosy appears to have been introduced into the Western hemisphere first by the Spanish and Portuguese invaders and later by negro slaves and Chinese immigrants the latter being also responsible for its introduction into many islands of the Pacific

The decline of leprosy in Europe dates from the fourteenth and fifteenth centuries This decline appears to have been mainly dependent on two causes the adoption of measures for isolating lepers from other members of the community and the improvement of sanitation and the standard of living It has lingered on longest in those countries and regions where these factors have been delayed

History in the light of recent investigations teaches that leprosy is a disease which belongs to a certain stage of civilization and to a certain standard of living Its spread

is chiefly dependent on the moving of large bodies of people such as armies slaves and free labour from endemic to previously unaffected areas History also shows that its decline and eradication depend on the awakening of the community to its nature on their adopting certain simple means of prevention and on improvement in the mode of living These principles are elaborated more fully in a later section of this book

(2) *Endemiology*

Leprosy is now regarded as a tropical disease but it is only in recent times that this term can be applied at all truly Until recently it was common in such cold countries as Norway and Iceland Its disappearance from temperate climates is largely due as we have already mentioned to the adoption of preventive and sanitary methods but warmth moisture and a certain density of population such as are found in some parts of the tropics, favour the spread of leprosy Social customs play a large part sexual and general promiscuousness such as is found among tribes of Africa and the Pacific Islands and also among semi aboriginal tribes in India being particularly favourable for the dissemination of the disease

In China leprosy is found chiefly in the warmer southern parts where the population is congested and sanitation particularly bad

In India leprosy is very widely distributed Among some aboriginal tribes it has been known for long and is limited by tribal laws and customs Among other tribes it was unknown until it was recently introduced by those who have left the isolation of the jungle and gone to labour in cities and industrial areas There they acquired the disease and on their return infected their fellow tribesmen The 1931 census gave the incidence of leprosy in the various provinces and States as in the following tables —

TABLE I

Distribution by Provinces and States (1931)

Province State or Agency	*Population*	LEPERS *Persons*	*Males*	*Females*	*Rate per 100 000*
INDIA Total	35 837 778	147 911	107 89	40 019	4
Provinces	271 526 933	126 867	93 281	33 586	46
Ajmer Merwara	560 292	18	1[illegible]	6	3
Andaman and Nicobar Islands	29 463	2	1	1	7
Assam	8 622 [illegible]51	5 164	3 864	1 300	59
Baluchistan (Districts and administered territories)	463 508	24	0	4	6
Bengal	50 114 002	20 845	15 290	5 555	42
Bihar and Orissa Total	37 677 576	13 329	14 408	4 9 1	54
(*a*) Bihar	5 727 500	9 457	7 614	1 843	37
(*b*) Orissa	5 306 142	5 9 4	4 3 8	1 596	111
(*c*) Chota Nagpur	6 643 934	3 948	2 466	1 482	59
Bombay Total	21 930 601	9 112	6 374	2 738	41
(*a*) Bombay Presidency	17 992 053	8 808	6 150	2 658	49
(*b*) Sind	3 887 070	277	197	80	7
(*c*) Aden	51 478	27	27		5
Burma	14 667 146	11 1 7	7 607	3 520	76
Central Provinces and Berar Total	15 507 723	11 506	7 341	4 165	70
(*a*) Central Provinces	12 065 885	7 344	4 415	2 929	61
(*b*) Berar	3 441 838	4 162	2 926	1 236	1 1
Coorg	163 327	17	11	6	10
Delhi	636 246	9	8	1	1
Madras	46 740 107	33 127	24 84	8 285	71
North West Frontier Province (Districts and administered territories)	425 076	249	164	85	10
Punjab	23 580 852	1 853	1 3 6	527	10
United Provinces of Agra and Oudh Total	48 408 763	14 485	12 013	2 472	30
(*a*) Agra	35 613 784	9 182	7 453	1 729	26
(*b*) Oudh	12 794 979	5 303	4 516	743	42
States and Agencies Total	81 310 845	21 044	14 611	6 433	25
Assam States	6 5 606	256	168	88	40
Baluchistan States	405 109	2[illegible]	21	6	6
Baroda State	2 443 007	575	393	182	24
Bengal States	973 336	400	316	93	45
Bihar and Orissa States	4 652 007	3 465	2 240	1 25	75
Bombay States	4 468 396	1 649	1 161	488	37

TABLE I—*contd*

Province State or Agency	*Population*	Lepers *Persons*	*Males*	*Females*	*Rate per 100 000*
Central India Agency	6 63 790	1 084	760	324	16
Central Provinces States	2 483 214	1 013	610	403	4
Gwalior State	3 5 3 070	4 5	27	153	12
Hyderabad State	14 436 148	3 738	2 630	1 108	6
Jammu and Kashmir State	3 646 243	2 0 6	1 381	645	62
Madras States Agency Total	6 754 484	3 728	2 739	989	55
(*a*) Cochin State	1 05 016	745	553	19	62
(*b*) Travancore State	5 095 973	2 789	2 037	752	55
(*c*) Other Madras States	453 495	194	149	45	48
Mysore State	6 557 302	733	536	197	11
Punjab States	437 787	227	162	65	56
Punjab States Agency	4 472 218	687	491	196	15
Rajputana Agency	11 225 712	543	382	161	5
Sikkim State	109 808	7	5	2	6
United Provinces States	1 06 0/0	304	235	69	25
Western India States Agency	3 999 250	148	109	39	4

Male lepers per 100 000	Female lepers per 100 000
59 3	23

TABLE II

Distribution by Age (1931)

INDIA *Age*	Lepers *Males*	*Females*
Total	10, 892	40 019
0 1	43	35
1 2	48	51
2 3	85	68
3 4	86	68
4 5	169	144
Total 0–5	*431*	*366*
5–10	1 473	1 036
10–15	611	1 600
15– 0	5 335	2 819
0– 5	7 277	3 316
25–30	10 8/6	3 968
30–35	12 758	4 325
35–40	14 230	4 590
40–45	13 868	4 379

TABLE II—*contd*

INDIA	LEPERS	
Age	*Males*	*Females*
45–50	12 079	3 895
50–55	10 030	3 348
55–60	6 568	2 403
60–65	5 175	1 073
65–70	2 316	859
70 and over	2 823	1 133
Age unspecified	40	9

Surveys carried out throughout India have shown that these figures while giving an indication of the relative frequency in different areas do not give anything like the true incidence and this is freely acknowledged in the census reports It would not be an exaggeration to multiply the census figures by ten and state that there are at least one million people suffering from leprosy in India

In Burma the incidence is widely scattered In Assam the disease is common in both valleys especially where labour has been imported from outside highly endemic areas In Bengal and Bihar there is a belt of high endemicity in the laterite area lying between the Chota Nagpur plateau and the Gangetic plane comprising Gaya the Santhal Parganas Birbhum Western Burdwan Manbhum Bankura and Midnapore This belt stretches down through Orissa and the east of the Madras Presidency from Balasore Puri Ganjam to Godavari Another highly endemic area in Madras is in Arcot and Salem districts while the disease is very common in Travancore Cochin and Malabar In the eastern and western divisions of the Central Provinces there is a high incidence In Nepal and in the adjacent districts of Bihar and the United Provinces leprosy is very prevalent while in the fertile area between the Ganges and the Jumna and extending into the plains of the Punjab the disease is comparatively rare In the Himalayan tracts such as Kumaun Simla Kangra and Kashmir leprosy is prevalent perhaps on account of the severe climatic conditions and the backwardness of the people

Previously leprosy in India tended to be confined to isolated foci recently the improvement of communications industrialism the breaking down of the isolating caste system and the greater mobility and freer mixing of the population favour the infection of formerly uninvolved areas

In *Africa* leprosy is one of the major problems In Nigeria alone it is calculated that there are no fewer than 200 000 cases making one per cent of the total population while there is reason to believe that in the Belgian Congo the incidence is considerably higher

It is impossible to estimate anything like the actual number suffering from leprosy in the world but the following table gives a rough calculation —

	Minimum	*Maximum*
China	1 000 000	1 500 000
India	500 000	1 000 000
Africa	500 000	1 000 000
British Empire outside of Africa and India	15 000	30 000
South America	100 000	150 000
Europe	6 000	10 000
Other countries	100 000	150 000
TOTAL	2 221 000	3 840 000

For a rough computation we may put the number as 2 to 4 millions in the world but it is possible that even the maximum figures give an under estimate

Leprosy is like tuberculosis in this respect that many are infected in whom the clinical disease never develops or gives discomfort to the patient Such cases are likely to pass unnoticed except in the careful examination of those who have been in contact with frank infectious cases Recent village surveys in North India in which careful examination of contacts has been carried out show 2 or even only 1 bacteriologically positive to 3 bacteriologically negative cases the criterion of positive and negative being the ordinary routine bacteriological examination

It is therefore obvious that under careful examination of contacts the number is bound to rise whereas when

figures are based on more desultory methods the number will be less

The *sex incidence* of leprosy is of interest In nearly all countries the disease appears to be more common in males than in females Before puberty the incidence is about equal in the two sexes and tends to be relatively increased in females at and immediately after puberty Later the disease is considerably more frequent in males The causes of these differences are probably chiefly environmental but may be to a certain extent physiological

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In later years he considerably modified this theory and acknowledged that sometimes it might be spread by eating food contaminated by a leper. Even in more recent years this theory has not been without its advocates and there is doubtless a modicum of truth in it. In famine areas and among poverty stricken people in India, Africa and elsewhere, dried or salted fish is frequently added to give flavour to an inadequate and badly balanced diet. As malnutrition is an important predisposing cause in leprosy, eating of preserved fish may be indirectly associated with leprosy.

While it is now fully accepted by all acknowledged authorities that the spread of leprosy is due to contagion, full proof is still wanting as to the exact paths by which the infection enters the body. The causal organism known as the *Mycobacterium lepræ* or *Bacillus lepræ* and more popularly as Hansen's bacillus (see fig. 1), or the lepra bacillus, is of very low toxicity. It can enter the human body and spread throughout the tissues without giving rise to any marked signs or symptoms. Infection may remain *latent*, or what is better termed *unrecognized*, for many years. Even highly infectious cases may show but few recognizable clinical signs and may pass in the community as healthy persons while they spread the infection to contacts. The latter again may show no symptoms and be unaware of having contracted the disease till years after contact took place. For this double reason the portal of entry is impossible to trace in the great majority of cases.

Experimental, cultural and serological evidence, so useful in tracing the early or latent stage in other diseases, is so far unavailable in leprosy, as there is no clear evidence that *B. lepræ* has ever been successfully inoculated in experimental animals or cultured outside the human body, nor has any serological test been devised for the recognition of cases not easily diagnosed by clinical or bacteriological examination.

CHAPTER II

ETIOLOGY

Throughout the ages two theories regarding the origin of leprosy have vied with one another for ascendency viz *heredity and infection*

In China Japan and North Africa the belief in hereditary transmission still exists In India it is not unusual for a patient who has been told that he is suffering from leprosy to raise the objection that no such disease has been present in his family for generations thus voicing the widespread belief that leprosy is a hereditary disease

In Europe in the seventeenth and eighteenth centuries and in the nineteenth century prior to the demonstration by Hansen in 1871 of the lepra bacillus the theory of hereditary transmission was widely accepted This was promulgated by such great authorities as Danielsson and Boeck in their book published in 1848 The Royal College of Physicians of London in their report of 1862 came to the conclusion that leprosy is not contagious and that there is no evidence which would justify measures for the compulsory segregation of lepers

The findings in favour of heredity and against the contagiousness of leprosy appear to have been founded either on investigations of experts who had studied the disease in very limited fields or on the opinions of those who had little or no practical experience of the disease The evidence brought forward by modern workers is overwhelmingly in favour of contagion as the means of the spread of leprosy

A third theory regarding the causation of leprosy was that put forward by Sir J Hutchinson viz that it is dependent on excessive consumption of decomposed fish

wounds or ulcers are all probable aids to infection We have no reliable evidence that leprosy is acquired by eating



FIG 2

And then after shaving healthy client with the same unsterilised razor

infected food by bathing in tanks or rivers used for the same purpose by lepers or by drinking water from the same wells

There is no proof that leprosy is inoculated by the bites of insects but they may occasionally act as carriers as flies bugs lice and ticks fed on leprous patients have been found to harbour the bacilli

There are instances of those who have apparently acquired leprosy by wearing the clothes or sleeping on the beds of lepers Others appear to have become infected without coming into direct contact by playing with bare knees on mats previously used by a leper or by living in a house vacated by one Thus there is some reason to believe that lepra bacilli remain alive for some time after

In syphilis and other diseases a marked primary lesion appears at the point where infection has entered In leprosy there may occasionally be considerable evidence that the first noticed lesion marks the original portal of entry but in the majority of cases the first recognized lesion is probably the result of generalized infection though its site may sometimes be determined by a previous injury to the part

Though chiefly on account of the reasons mentioned above we cannot define with certainty the method of infection there is considerable evidence that lepra bacilli enter



Fig 1
Barber shaving a leper

through wounds and abrasions of the skin or mucous membrane in those who are exposed by contact with infectious cases (figs 1 and 2) The picking of the nose by the worm infected child scratching of the skin irritated by the bites of insects or by pruritic diseases the existence of

has also the degree to which mixing takes place between different castes and classes In surveys carried out in Indian villages single caste villages were found least affected while mixed villages in which the houses of several castes stood side by side showed the highest incidence Statistics prove that house and especially room and bed contacts are the most dangerous while the more occasional village and occupational contacts are less likely to result in infection

We may therefore summarize the factors most favourable to the spread of infection as the infectiousness of the infector the closeness and length of contact and the lack of resistance of the infectee As we shall show later when we deal with prevention all these factors must be assessed

leaving the body but their vitality apart from the host can only be surmised from the analogy of other acid fast pathogenic organisms such as the tubercle bacillus and the bacillus of rat leprosy

There is strong evidence to support the hypothesis that infection in the majority of cases takes place through direct close contact The closer and more prolonged the contact and the more infectious the leper the more likely is the disease to be acquired

Only a certain proportion of cases of leprosy can be considered infectious Recent surveys in the villages of India show that on an average out of ten cases one is highly infectious one is less infectious and eight are non infectious Our criterion of non infectiousness is failure to find *B lepræ* in repeated examinations of the skin and nasal mucous membrane the examinations being made by one of the smear methods mentioned in Chapter XII

The cutaneous type of leprosy is the usual source of infection Clumps of bacilli are sometimes found in superficial scrapings of the epithelial scales taken from the surface of the epidermis The nasal discharge and droplets from the mouth especially when the patient sneezes coughs or breathes heavily may be found laden with bacilli When lepra fever (lepra reaction) occurs nodules of the skin and nose are apt to ulcerate and discharge bacilli in still larger numbers

Another important factor regulating the likelihood and degree of infection is the resistance of the person exposed The resistance of children especially those in the first few years of life is particularly low This is proved by the frequency and severity of the infections which take place and is confirmed by the lepromin test (see Appendix III) The resistance of both children and adults is reduced by accompanying diseases poor nourishment and unhealthy living also by the strain on the system connected with puberty and child bearing

Lack of personal hygiene and insanitary surroundings have important bearings on the spread of the disease so

has also the degree to which mixing takes place between different castes and classes In surveys carried out in Indian villages single caste villages were found least affected while mixed villages in which the houses of several castes stood side by side showed the highest incidence Statistics prove that house and especially room and bed contacts are the most dangerous while the more occasional village and occupational contacts are less likely to result in infection

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CHAPTER III

BACTERIOLOGY

Leprosy is caused by the growth of *Mycobacterium (Bacillus) lepræ* (Hansen 1871) in the body and the reaction of the tissues to its presence (fig 3)

B lepræ average 6 to 8 μ in length The typical vegetative forms resemble tubercle bacilli in appearance and in staining reactions They may sometimes be distinguished from the latter by their bunch like arrangement and large number by their straighter or less curved appearance and by the sites in which they are found in the body but the only final method of distinguishing the two organisms is by experimental inoculation *B lepræ* producing no progressive disease in rabbits and guinea pigs in contrast

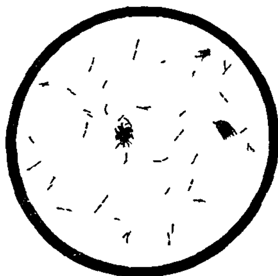


FIG 3

Smear from under surface of leprous nodule Note large bundles of bacilli also granular partly-stained appearance of some of the bacilli

to *B tuberculosis* The leprosy bacillus is rather less acid fast than that of tuberculosis when stained by Ziehl Neelsen s method

Many workers have claimed to have cultured *B lepræ* from leprous material but none of these claims have as yet been fully confirmed Non pathogenic acid fast or potentially acid fast organisms are often present on the surface of the body in the nasal mucosa and even inside the tissues and doubtless many of the supposed cultures were dependent on want of recognition of this fact Again increase of bacilli on artificial media is difficult to establish unless progressive macroscopic growth is noted The large numbers of bacilli found in smears taken from the first inoculated tubes or even from subcultures have led workers to claim multiplication they had probably not realized the great number of bacilli contained in the original material placed in the tubes In other instances macroscopic changes have been noticed in and round bacillus laden material inoculated on solid media these changes due to the tissue cells have been erroneously interpreted as indicating bacillary growth

Fraser and Fletcher using the media employed by the leading previous workers and taking their material under careful aseptic precautions from the under surface of leprous nodules failed to obtain successful results

More recently American workers using certain gas concentrations claim to have cultured and repeatedly subcultured *B lepræ* these results still await full confirmation

Attempts to transmit leprosy in a progressive form to experimental animals have met with no greater success Local nodules can be caused by inoculating living bacillary suspensions but similar nodules are produced when the suspension has been previously killed by boiling *B lepræ* will retain their morphological and staining characteristics for more than twelve months when inoculated into rats and may be found carried to other parts of the body such as the liver or spleen but these characteristics are retained

equally well whether the bacillary suspension inoculated is fresh and presumably living or has been killed by heat

Some workers have suggested that *B lepræ* and *B lepræ muris* (the causal organism of rat leprosy) are identical Inoculation of *B lepræ* into rats however fails to produce progressive disease whereas inoculation of the rat leprosy bacillus causes progressive disease in a hundred per cent of surviving rats

These two organisms are similar in appearance and staining properties both of them have so far apparently eluded culture on artificial media and successful inoculation except each in one vertebrate genus

CHAPTER IV

DISTRIBUTION OF LESIONS—INCUBATION PERIOD

Distribution of Lesions

Leprosy is a systemic disease affecting principally the skin and certain mucous membranes and the peripheral nerves but also in severe or advanced cases most of the organs and tissues of the body

A notable exception is the *central nervous system* which is seldom if ever attacked Lie claims to have found lepra bacilli in the ganglion cells of the spinal cord and in the vessels of the medulla oblongata but these had given rise to no symptoms during life Degenerative changes occasionally found in the dorsal columns of the spinal cord are secondary to the peripheral neuritis of neural leprosy

The *muscles* are not invaded by the infection but are subject to trophic changes secondary to interference with their nerve supply

The *heart* is not directly affected though degenerative changes may result from toxins engendered by mixed infection or in the complication known as lepra fever

The smaller *blood vessels* especially the smaller branches in lepromatous areas are profoundly affected This is referred to later in the description of skin and nerve lesions

The *lungs* are possibly attacked in a small proportion of severe cases and special reference is made later to pulmonary complications

The *gastro intestinal tract* and the *urinary tract* are as far as is known almost or entirely immune from leprous lesions though degenerative changes due to secondary toxaemia are often present

The *liver* and *spleen* are frequently found at autopsy to be lepromatous and are sometimes found clinically to be enlarged especially during febrile reactions in severe cases But the affection of these organs is apparently of but little clinical importance In mixed infections degenerative changes may be caused

The *testes* are affected to a greater or less extent in cutaneous leprosy the affection being both inter-tubular and intra tubular The organ may in the end be converted into a mass of fibrous tissue

The *lymph nodes* are affected in all cases of cutaneous and in some cases of neural leprosy The nodes are as a rule swollen as a whole without alteration in form On section the ampullæ and medullary cords are of a yellowish colour easily distinguishable from the appearance in tuberculosis Both infections may however be present simultaneously in the same node Diagnosis of leprosy is sometimes aided by the examination of sections or of aspirated material from enlarged nodes Leprous infection spreads through the lymph spaces of the skin and up the lymph vessels to the nodes which act as filters and may limit or impede to a certain extent the further spread of the disease

Incubation Period

The onset of leprosy may be sudden and dramatic or it may be slow and insidious We have seen a child of six weeks with lesions scattered over the body while in others no lesions have been noticed till 20 years after the last possible chance of infection One patient noticed a single slight lesion which made no progress for twenty two years after which careful examination showed leprous thickening of a nerve in another part of the body The incubation period depends on the resistance of the infectee and on the degree of infection on an average it is probably about three years

CHAPTER V

Clinical and Histological Features of Skin Lesions

(1) *Introductory*

Although leprosy has been shown to be a general disease affecting directly or indirectly most of the organs and tissues of the body it is in the integuments (skin and mucous membranes) and in the peripheral nerves that the clinical and histological changes produced by the infection can best be studied

Though leprosy is commonly divided into cutaneous and neural leprosy according to whether skin or nerve is clinically affected yet in all but a very small minority of cases both are the seats of infection The typical leprosy lesion is neuro cutaneous and in studying typical leprous lesions in their clinical and histo pathological aspects it is convenient to consider the cutaneous nerves and the skin as one unit

The severity of the disease and rate of spread through out the body vary greatly in different cases A single well defined macule a few centimetres in diameter may remain as the only sign of leprosy for a number of years In contrast to this the infection may spread through almost the entire skin of the body without showing any noticeable clinical appearances to indicate its presence Intermediate between these two extremes we have innumerable grada tions in the number and size of foci and in the degree of clinical signs produced As will be shown later these variations are largely dependent on the degree of resistance of the patient to *B lepræ* and on the consequent degree of cellular reaction to these organisms

(2) *Anatomy of the Skin*

To make clear the ways in which leprous infection spreads in the skin a short description of certain aspects of its anatomy may be found useful (see fig 4) The skin consists of the epithelial layers (cuticle) and the corium (cutis) The papillæ of the corium penetrate the epithelium and interlock with the interpapillary processes of the latter The epithelium sends processes into the deeper layers of the corium in the form of the hair follicles and coil glands There are two main vasculo neural plexuses each consisting of arterial and venous vessels and nerve branches these are the subcutaneous plexus lying between the skin and the subcutaneous tissue and the subpapillary plexus lying below the level of the papillæ The deeper of these plexuses receives branches from the subcutaneous nerves and vessels and it again sends branches which pass up along the hair follicles and sweat ducts to the superficial (subpapillary) plexus The subpapillary plexus supplies branches to the papillæ The hair follicles and sweat organs are surrounded by vessels and nerves and between and around them there lies the matrix of the corium consisting chiefly of collagenous and elastic fibres and fibroblasts

The epithelium is non vascular but lymph penetrates the basal or germinal layer and bathes the cells of the Malpighian layer carrying the melanin granules from the pigment cells which surround the papillary vascular plexus The flattened superficial cells of the epithelium (strata granulosum lucidum and corneum) are capable of being profoundly affected by pathological conditions in the corium

(3) *Spread of infection in the skin and nerves*

When leprous infection is introduced into the skin it is either destroyed by phagocytic cellular action or it spreads along the lines of neuro vascular plexuses Under certain circumstances such as lepra fever and when a severe temporary reaction takes place the blood cells invade leprous lesions and phagocytose the bacilli But we have

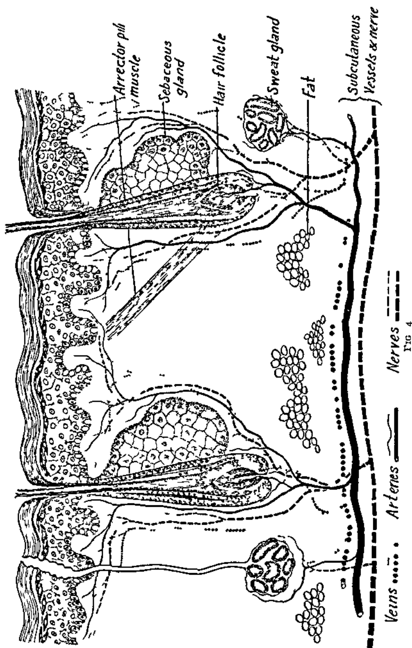


DIAGRAM OF SKIN SHOWING DISTRIBUTION OF BLOOD VESSELS AND NERVES

FIG 4

reason to believe that under ordinary conditions the cells responding to the presence of *B lepræ* in both the skin and nerves belong to the reticulo endothelial system and lie in the perivascular tissues The cells of this system are given various names according to their situation and functions The tissue cell known as the 'macrophage is probably that concerned in the phagocytosis of B lepræ and we shall use this term in our description it is found chiefly in the proximity of the vessels

The multiplication of lepra bacilli which have entered the skin takes place in the intercellular lymph spaces and inside the cells The degree of this multiplication and the subsequent spread of the organisms through the skin are largely dependent on the degree of cellular response this again being dependent chiefly on the resistance of the patient

In cases in which the resistance is low the infection spreads rapidly along the plexuses passing from the subpapillary plexus along the papillary branches into the papillæ Sometimes the spread is confined to the more superficial layers of the skin It is common however sooner or later for the infection to spread down the neuro vascular structures surrounding the follicles and sweat ducts to the subcutaneous plexus

The infection may then spread along the deeper plexus and from it re invade the more superficial structures

At the same time infection passes from the deep plexus up the afferent sensory nerve branches thus the peripheral nerves become involved by direct invasion from the skin

(4) *Tissue Reaction to B lepræ in the Skin*

As the infection spreads along the various plexuses and their branches the perivascular cells respond to the presence of the bacilli This reaction of the cells to the bacilli in their neighbourhood is three fold viz multiplication of cells by division ingestion of bacilli by the macrophages and under favourable circumstances destruction of bacilli The degree of reaction is in direct proportion to

(a) the number of bacilli present locally and
(b) the reacting power of the cells

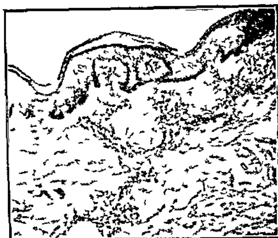


FIG 5

Peri a cul infiltration in the pap llæ nd sub papillary plexu in a sect on from the sp eading dge of a m cule of the cut neous type

Round the bacillus invaded plexuses and vascular branches therefore is formed a cellular infiltration originating from the multiplying perivascular cells This infiltration is greater or less dense or loose according to the reacting power of the cells and the number of bacilli present to call forth the reaction It is this cellular multiplication and infiltration which produce the clinical lesion

In the margin of a recent lesion in which the reacting power is strong the bacilli are effectively phagocytosed and a dense cellular granuloma is produced with few or no bacilli left undestroyed

If however the reacting power of the cells is weak the bacilli continue to multiply in the intercellular spaces and in the cytoplasm of the cells (fig 6) In sections of such a lesion we find many bacilli but *compared with the number of bacilli* there is only meagre cellular multiplication and only a loose granulomatous appearance round the vessels hence the visible and palpable clinical signs may be slight or even nil

Thus we have at one extreme the small clearly defined macule a few centimetres in diameter appearing in the

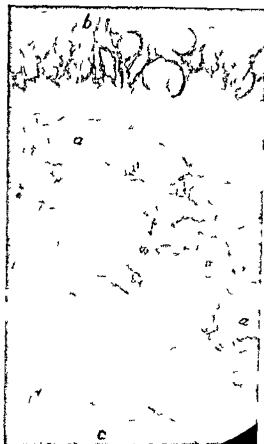


FIG 6

Section of margin of spreading lesion in papillary layer in cutaneous type of leprosy Notice absence of cellular reaction in spite of presence of numerous bacilli

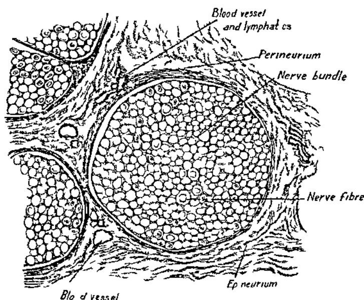
resistant case and at the other the widespread skin infiltration sometimes with little or no clinical signs in the case with low resistance

(5) *Neural Infection from the Skin*

While infection spreads along the cutaneous plexuses it invades at the same time the sensory nerves supplying the affected skin Sections of small sensory branches show the bacilli lying between the nerve fibres in the interior of the nerve bundles In the skin the bacilli are found in

close proximity to the capillaries and therefore to the perivascular macrophages In the nerve bundles they are separated by the nerve fibres from the capillaries which lie chiefly in the perineurium between the bundles (see figs 7 16 17 and 57)

DIAGRAM OF SECTION OF NORMAL NERVE



FIG

Response of endothelial cells to lepra bacilli appears to be determined partly by proximity Thus in cases with moderate resistance the bacilli are more readily destroyed in the skin than in the nerves In the latter they are apparently sheltered by the intervening nerve fibres from the phagocytic action of the cells while in cases with low resistance i e of the cutaneous type we find massive infection of both skin and nerves with marked cellular infiltration of the skin and but little infiltration of the nerves

In the neural macule we find dense granuloma in the skin and few or no bacilli while in the supplying nerves there is also granulomatous infiltration but bacilli may be

found in considerably greater numbers in the parts of the nerve bundles most distant from the neural capillaries

Consequently a greater degree of resistance is necessary to produce entire destruction of bacilli in the nerves than in the skin In cases with moderate resistance the infection may be entirely cleared up in the skin while it still persists inside the peripheral nerves

There is a possibility that the bacilli may again find their way into the skin from their nerve reservoir during any period of temporarily lowered resistance In any case it is not uncommon to find during such a period an actively spreading lesion at the periphery of a residual apparently healed macular area

The above observations regarding the nature of neural leprosy are to a certain extent hypothetical and require further confirmation but so far no other hypothesis has been advanced which satisfactorily explains the various perplexing phenomena connected with this type of leprosy

(6) *Variations in Resistance*

We have spoken of the difference in the histological and clinical appearances of lesions determined by the degree of resistance Another important factor in determining the nature of lesions is *variations* in resistance The causes determining these variations are fully discussed in Chapter XIV

If resistance is lowered for a short time the bacilli multiply and spread in both the skin and nerves If resistance is restored in time there is a severe local cellular reaction called forth to deal with the bacilli which have meanwhile accumulated This may be called Recovery or Convalescence Reaction It produces very definite clinical signs both in the skin and in the nerves and occurs frequently during recovery from some intercurrent illness or other debilitating causes in cases of mild leprosy (see Chapter IX the last section)

If however the intercurrent cause of lowered resistance is too prolonged or too severe there is a danger that resistance to leprosy may become permanently lowered and

restoration to health is not followed by a sufficiently strong cellular reaction to control the disease or the reaction may lead to complications which again lower the resistance

Occasionally the resistance of the skin infected with B lepræ is sufficient to prevent the formation of a clinically detectable cutaneous lesion but not sufficient to prevent the passage of the bacilli up its afferent nerve branches and through them into a mixed nerve such as the ulnar This invasion of a main nerve causes thickening and tenderness with secondary trophic motor and sensory symptoms Such cases of pure nerve leprosy are comparatively rare Where a nerve is affected there is generally a skin lesion in its area of distribution or signs (such as a scar) that such a skin lesion previously existed

Self healing

It must be clearly understood that like tuberculosis leprosy may be a very slight disease the infection proving abortive and the lesions healing up spontaneously without special treatment Indeed there is good evidence that self healing takes place in a very large proportion of those infected in an endemic area This self healing is largely dependent on a timely restoration or improvement of the general health of the patient

At a much more advanced stage of the disease self healing frequently occurs In patients of the C 3 type the infection will gradually die out the cutaneous giving place to the secondary neural form till only crippling and deformities of the face and limbs are left as signs of the former disease The reason for the destruction of lepra bacilli in these cases is difficult to determine

Mode of Onset

The onset of leprosy appears in different forms When acute lesions may suddenly appear *in the form of nodules* or macules which may be permanent or evanescent When chronic a single macule may first appear with greater or less sensory changes or there may be thickening and tenderness of a nerve such as the ulnar with trophic sensory or motor changes in the region of distribution

CHAPTER VI

DIFFERENT TYPES OF LESIONS

Before describing these in detail it is necessary to consider two words commonly used in leprosy viz leproma and leprotic the former being used as a substantive and the latter as an adjective In the Leonard Wood Conference Report the term *leprotic* is applied to those changes which present clinical and microscopic evidence of inflammatory processes typically of granulomatous nature which are apparently caused by *Mycobacterium lepræ* in them In such lesions the organism can generally be demonstrated by ordinary methods of examination

It has been stated by some authorities that the term *leprotic* should be reserved for lesions of the cutaneous type and that it is not applicable to the tuberculoid' and other neural lesions Seeing that the latter are also apparently caused by the presence in them of *B lepræ* (though sometimes these organisms are difficult to demon strate probably for the reasons mentioned above) we do not agree with this limited usage of these words and we shall use them in connection with all lesions in which we believe that a cellular reaction is produced by the presence of *B lepræ*

We have described the general pathogenesis of skin and nerve lesions We shall now describe different types of lesions in more detail

(1) *The Macule*

This term is ordinarily used to describe a discoloured skin area which is not raised above the surrounding skin surface but in leprosy for want of a better term it is used

somewhat loosely to describe any discoloured skin lesion even though it may be raised above the surface of the surrounding skin In shape it may be round oval or irregular and the size varies to a considerable degree

On inspection and when palpated by the finger or picked up between the finger and thumb it may be thin and flat raised above the surrounding skin and indurated in its entirety or raised and indurated at the margin with a flat thin centre (see figs 8 to 12 and 35 to 37)

In colour it generally shows hypo pigmentation as compared with the surrounding skin this being most marked in dark skins Hypo pigmentation is often hidden by erythema which is present either throughout or only at the margin Redness due to capillary congestion may be removed by pressure with a watch glass but such pressure does not remove permanent hypo pigmentation which is found chiefly in areas where resolution has taken place

The skin pattern is changed and shows either exaggeration or diminution of the natural skin markings Para keratosis may be present with dry scaliness or hyper keratosis with thickened epithelium

Anidrosis (fig 40) and depilation are common due to leprotic infiltration round the sweat glands and hair follicles or to interference with their trophic nerve supply

Sensory changes vary in degree in direct proportion to (*a*) the depth of skin involved (*b*) the degree of involvement of the supplying nerves (*c*) the vigour of the cellular reaction and consequently the density of the leproma both in the skin and nerves The chief forms of sensory change are anæsthesia to light touch analgesia to pin pricks loss of sense of heat and cold paræsthesia in the form of inability to locate touch accurately Hyperæsthesia may precede anæsthesia

There is therefore a great variety in the possible clinical and histological signs of a leprous macule In young children with low resistance there is the flat slightly hypo pigmented macule of juvenile leprosy indistinguishable from the surrounding skin on palpation but showing

perhaps a little keratosis and slight redness on careful inspection So slight indeed are the signs that the diagnosis may have to depend partly on the history of contact or a definite diagnosis may be impossible for a time (See Chapter XI section 5)

In contrast to this indefinite form there is the so called tuberculoid macule found in cases with comparatively high resistance this type generally shows considerable induration marked anæsthesia in the whole or in part of the area also erythema keratosis depilation and anidrosis

Between these two extremes typical of high and low resistance there is a great variety of macules shaped and moulded chiefly in accordance with the ebb and flow of the reacting power of the tissues to *B lepræ*

Macules when first noticed vary in size from 2 mm up to several centimetres Under certain circumstances they tend to spread centrifugally until they cover large areas of the body though at any stage their progress may become arrested and they may remain stationary for years As they increase in size the margins of neighbouring macules merge thus gradually almost the whole body may become covered The speed with which this is accomplished depends on the number of macules and the rate of their spread

(2) *Tuberculoid Lesion Resistant or Neural Macule*

Under these various terms we describe a form of leprosy comparatively common in North India Japan West Africa and other places but apparently less common in some endemic countries

Clinically this lesion is generally of a circumscribed nature Either throughout or only at the margin it is raised above the surrounding skin and is felt to be thickened and indurated when picked up between the finger and thumb It is therefore a *macule* using this term in the looser sense mentioned above It is generally anæsthetic to light touch but not invariably so The indurated area is generally erythematous and may show a scaly appearance Depilation and anidrosis are generally marked

Histologically the granuloma is of a nature composed chiefly of epithelioid



out the interpapillary processes Bacilli are few in number and may be impossible to find



FIG 9
Neural macules with uniform thickening

This type of lesion is found as a rule in highly resistant cases The epithelioid cell is the active phagocyte which destroys bacilli as compared with the passive foamy lepra cell generally crowded with bacilli which is found in the lesions of cases with low resistance

In the tuberculoid lesion giant cells are common These are a sign of very active local reaction to the bacilli in the attempt of the cells to surround localize and destroy the organisms If this process is even more active caseation and even necrosis followed by ulceration may result

Cases with tuberculoid lesions are conveniently classified under the neural type seeing that anaesthesia to light touch and other neural signs are generally marked

features and massive infection with bacilli characteristic of the typical cutaneous case is absent

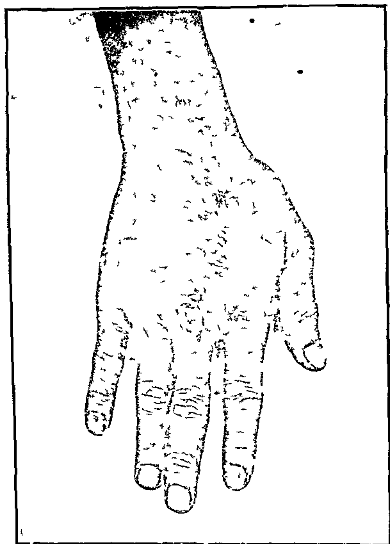


FIG 10

Slowly spreading neural (tuberculoid) macule the only lesion found in the body

The marked neural signs (sensory trophic and vascular) may be dependent partly on the dense nature of the leproma

and its pressure on the terminal nerve fibres in the skin but they are due chiefly to bacillary invasion of the sensory



Fig 11
Uniformly thickened neural (tuberculoid) macules

nerve branches lying in the subcutaneous tissue and consequently the formation in these branches of a dense leproma similar to that in the skin This process we have described later in detail

(3) *Generalized Infiltration*

Speaking generally the less resistant the patient the less conspicuous are his macules the greater is their number and the more rapid is their centrifugal spread The reasons for these facts have been made clear above

In cases with low resistance the centrifugal spread from skin foci is often more or less concealed and the whole skin may become infiltrated without showing any appearance of spreading macules This is because of the almost

symbiotic relationship between cells and bacilli the former reacting only in a slight degree to the latter not sufficiently to produce clinically conspicuous lesions



Fig 12

Reacting neu l (tubercul id) macul Small number of ba illi wer f und in se tions The le on fl ttened out and the bacilli dis pp red spontaneously after a few weeks

Mistakes have frequently been made by clinicians on this account Cases with widespread infiltration have often escaped clinical detection even under expert examination and yet bacteriological examination showed massive infection of the corium and even clumps of bacilli in the superficial layers of the epithelium Such patients are the most dangerous spreaders of infection as they may mix freely in the general community without their condition being suspected

On the other hand the diffuse leprotic lesion may cause considerable thickening of the skin When this occurs in the face corrugation may occur Thus we have the well known lion like appearance (leontiasis) often seen in

advanced cases of leprosy generally accompanied by marked thickening of the ears (fig 51)



Fig 13

Section of neural tuberculoid macule showing dense clearly defined cord like gran loma Note thickened granulomatous nerve branches in cross section in subcutaneous tissue

It has been stated that leprous lesions of the palms of the hands soles of the feet and the scalp do not occur



FIG 14

Diffu e le on cau ng mosai like pattern

Such lesions are however quite common though the thick ness of the epithelium nt the palms and soles and the deneness of the scalp and its hairy covering render them less conspicuous than other lesions

(4) *The Nodule*

This is defined in the Report of the 1931 Leonard Wood Memorial Conference as follows — A nodule is a definitely thickened rounded circumscribed mass of leprotic nature commonly occurring in the skin sub cutaneous tissue or mucosa

Nodules may be found in skin which was formerly free from infection but they are more commonly super imposed on skin already infiltrated with a diffuse form of the disease

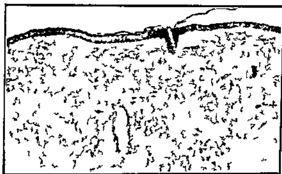


FIG 15

Section of nodule Notice the flattened epithelium with œdematous layer underlying it the destruction of hair follicles and congestion of blood vessels in the granuloma

During lepra reaction temporary nodules often appear and again disappear when the reaction passes off but true nodules are of a more permanent nature The nodule is composed of typical leprotic tissue with large numbers of foamy vacuolated lepra cells most of which contain masses of lepra bacilli There is also an admixture of plasma and small round cells and a greater or less amount of fibrous tissue binding the whole nodule together The fresh nodule is as a rule soft and vascular As it becomes older the fibrous tissue tends to contract and render it hard and non-vascular A nodule may be superficial or deep It may be confined to the skin or to the subcutaneous tissue or it may extend into both these tissues The most common sites are the exposed parts of the body such as the face

and ears hands and feet knees and elbows but nodules may occur almost anywhere on the surface of the body or in the nose mouth and pharynx Exceptions are the palms of the hands soles of the feet and the scalp the dense tissues of these parts seldom allowing actual nodulation

Under certain circumstances nodules are liable to ulcerate pressure from below on the epithelium causing its destruction During *lepra reaction* they are liable to form abscesses these in turn may burst and either at once heal up after discharging their contents or form ulcers which tend to remain open until a large part of the under lying leproma has gradually been eliminated

The pus of acute leprous abscesses is found to contain not only the cellular elements of the skin and lepra cells but also monocytes and polymorphs of hæmic origin These leucocytes are found full of lepra bacilli Such acute abscesses should be contrasted with the subacute or chronic nerve abscesses described in the next chapter

The reason for the formation of nodules is uncertain One cause suggested is the occurrence of bacillary emboli round which cellular proliferation takes place Another probable cause is the multiplication of bacilli in foci at points where minor injuries have taken place and the injured tissues are less able to restrict the growth of the organisms Later the healthy cells in the surrounding tissues react and invade these bacillary foci and this reaction results in nodules This latter hypothesis accounts for their greater frequency at points liable to injury

CHAPTER VII

Clinical and Histological Features of Nerve Lesions

(1) *Mode of Invasion of Nerves*

While there is a possibility that in certain cases the peripheral nerves become infected with *B lepræ* through the blood stream there is reason to believe that infection of the nerves takes place principally by ascending invasion from the skin *B lepræ* finding their way up the sensory branches from the subcutaneous plexus Strong evidence in favour of this mode of entry may be gathered by the study of early single lesions where a limited area of skin is affected in conjunction with two supplying sensory nerves of widely different origin Thus in one case the only skin lesion found was the lobe of the ear and the only nerves which were found affected were the great auricular and the posterior branch of the auriculo temporal In another case the only lesion was a macule on the back of the hand the local sensory branches of both ulnar and radial nerves were markedly thickened Similar examples occur so frequently that we are led to believe that the skin is first affected and that the supplying nerves are invaded secondarily from the skin Not infrequently however the infection may later become destroyed in the skin while it still persists in the nerves for as we have mentioned above *B lepræ* can apparently persist and grow more readily in the nerve bundles than in the skin For this reason the nerves may act as bacillary reservoirs

We have already mentioned that infection may pass along the subcutaneous plexus and thence spread up around the hair follicles into the papillary and subpapillary

layers There it gives rise to fresh granulomatous foci appearing clinically as papular eruptions beyond the margin of the visible skin lesion (pioneer papules) It is possible that infection may spread likewise from sub cutaneous nerve reservoirs into the skin either re infecting old lesions or invading new areas in the neighbourhood This would occur during a period when the patient s general resistance was lowered due to any intercurrent disease or other cause of temporary debility

This hypothesis would explain the persistence of single skin lesions such as those of the tuberculoid type which show few or no bacilli in smears or sections but remain active though often with little apparent change in size or form for periods of months or even years Constant or intermittent re infection of the skin from the supplying nerve branches would account for this persistence the bacilli like a well regulated fuel supply being consumed as

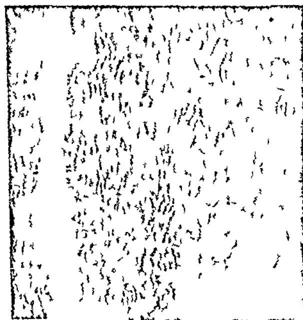


FIG 16

Longitud nal section of nerve branch in cutaneous type Not n s s of b illi lying b tw n nerv fibre nd absence of cellul r re ction

they enter the skin and thereby maintaining the chronic inflammatory reaction

In cases with low resistance infection is able to spread unimpeded up the nerves from the skin giving rise to little or no cellular response There is therefore a corresponding absence of neural signs Hence the comparative absence of these in the frank cutaneous case with low resistance It must not be supposed that in such a case the nerves are not *infected* more bacilli are found in the nerves in cutaneous than in neural leprosy (see figs 16 and 17)

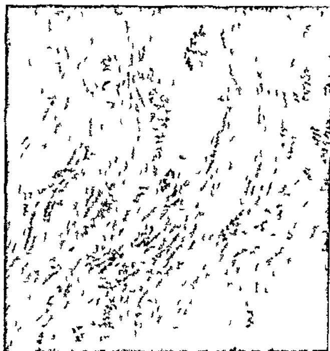


FIG 17
Higher magnification of last figure

Anæsthesia and other neural signs are not due to toxins set free from bacilli nor are they due to pressure of the bacilli on the nerve fibres They are due to the mechanical pressure of the granuloma caused by vigorously reacting and multiplying cells connected with the inter- and intra fascicular capillaries of the nerves (see figs 7 and 13) This reaction of the cells is called forth first by the bacilli

in the neighbourhood of the capillaries and later as cellular division and penetration progresses by bacilli lying between the nerve fibres in the parts more distant from these vessels

A transverse or oblique section of a small nerve branch at this stage may show in the centre dense leproma absence of bacilli and destruction of nerve fibres and at the periphery the presence of bacilli absence of leproma and nerve fibres entire Thus it is in resistant cases as compared to non resistant that we find few bacilli in the nerves but more marked neural signs and symptoms

It may be asked how can the bacilli find their way up the sensory nerves to the main trunks in resistant cases how can they run the gauntlet of the phagocytic cells in the lower reaches of nerves? The reason is probably to be found in the fact that resistance is not a constant factor While in some cases it is higher than in others in all it varies from time to time During the low periods the bacillary invasion progresses while during the high periods cellular reaction takes place

In their passage up the nerves bacilli tend to accumulate at points of obstruction or injury Obstruction is liable to occur where branches enter or where the nerve passes round a muscular fibrous or bony bend or traverses a narrow passage Superficial nerves are liable to injury especially when they lie adjacent to the bone When resistance is restored it is at these points where bacilli have accumulated that thickening and tenderness of nerves is most marked as large masses of bacilli call forth stronger cellular response than single organisms Hence the thickening of the ulnar above the elbow of the peroneal as it passes round the fibula and behind the knee and of the great auricular as it passes round the sterno mastoid muscle these three being among the commonest lesions found in nerve leprosy

(2) *Nature of Nerve Lesions*

The nature of leproma in nerves is very similar to that in the skin In cases with low resistance the chief feature

is the 'lepra cell' with its vacuolated foamy appearance and its ingested bacilli and the small round cells chiefly at the margin

In the more resistant cases the epithelioid cell apparently of similar origin takes the place of the lepra cell and bacilli are comparatively few Also in these cases as in the skin there are often abundant giant cells (fig 18)



FIG 18

Giant and epithelioid cells in section of tuberculoid lesion

Caseation is much more common in the nerves than in the skin and this frequently goes on to abscess formation The nerve sheath (epineurium) is generally thickened sometimes to a very considerable extent This is due to cellular reaction to the bacilli and tends to prevent the spread of infection into the surrounding tissues In resistant cases therefore the bacilli are shut up within the nerves the possible avenues of escape would be through the sheath or through the skin but both these avenues are closed by

cellular reaction But the bacilli may remain and multiply inside the nerves which as we have shown form a more favourable medium for their life and growth

(3) *Nerve Abscess*

Caseation in leprous nerves going on in extreme cases to abscess formation is analogous to the similar occurrence in lymph nodes in tuberculosis It is most likely to occur at points where bacilli concentrate due to obstruction of their passage up the nerves There may be caseation alone or caseation with liquefaction at the centre or the whole may become liquefied inside a fibrous capsule An abscess may remain in the centre of the nerve forming a fusiform swelling or it may escape from the centre of the nerve and form a sack like projection attached to the side



FIG 19

Ab ss of ulnar nerve Note thick ed nerve above and below ab ss

of the nerve (see fig 19) The greater the pressure exer cised by the pus on the nerve fibres the greater are the neural signs in the region of its distribution Abscesses sometimes burst spontaneously discharging their contents but they tend as a rule to remain encapsulated for a consi derable time Evacuation is followed by greater or less relief of nerve symptoms according to the degree of pres sure which the abscess has been exercising on living nerve fibres

Nerve abscesses may be sub acute, but they are more commonly chronic They may be single or multiple They are formed in nerves of all sizes from small cutaneous branches to large mixed nerves like the ulnar There may be a series of abscesses in the course of one nerve In our experience they are found most frequently in the ulnar the medial cutaneous of the forearm the auricular and the sural nerves

Examination of a nerve abscess may fail to show acid fast bacilli They are found more frequently singly or in masses in the white pus or caseous material than in the capsule or among the neighbouring nerve fibres In these cases the bacilli have apparently been cut off from the

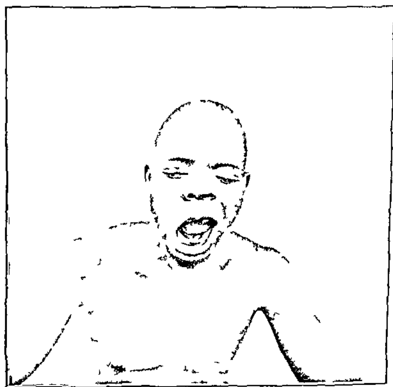


Fig 20

Unilateral facial paralysis in neural leprosy due to constriction of the affected facial nerve in the bony canal.

phagocytic cells and preserved intact by the surrounding pus or caseous material

(4) *Constriction of Nerves*

Tissue reaction to *B lepræ* may result in considerable thickening of the epineurium which thus forms a firm unyielding nerve sheath When inside such a sheath an acute inflammatory process occurs with congestion and swelling considerable pressure is brought to bear on the nerve fibres causing blocking of their function and if



FIG 21

P r i of right side of occip to f ntalis muscle following constricti i the bony l of th ckened supra-orbit l nerve. The thickened nerve on the left side pa sed ov r a groove and thus escaped constriction

pressure is severe and prolonged their destruction Even more severe constriction of nerves is liable to occur at points where they pass through rigid canals In some cases the ulnar nerve is bound down to the bone by thick fibrous tissues as it passes round the bend of the elbow, and the peroneal nerve is similarly bound down as it passes round the fibula (fig 70) Sudden swelling of the nerve may lead to considerable permanent motor trophic and sensory disturbances unless the constricting fibrous bands are promptly incised

Similarly complete unilateral facial paralysis may result from the nipping of a swollen facial nerve as it passes through the stylo mastoid foramen (fig 20) But a much more common occurrence is the facial paresis which is found in cases of the resistant (neural) type when extensive lesions are present on the face giving rise to the mask like expression so typical of this form of the disease (figs 29 and 30) Anæsthesia of the skin of the face is accompanied by paresis of the underlying muscles of expression including often the *orbicularis palpebrarum* and even the *orbicularis oris* This is probably not due to a lesion of the facial nerve but the tone of the facial muscles is lost as the result of the overlying anæsthesia Similarly when the supra orbital nerve is nipped in a bony foramen in its passage into the orbit the resulting unilateral frontal anæsthesia is accompanied by paresis of the corresponding portion of the occipito frontalis muscle (fig 21)

due to c
ouy canal

CHAPTER VIII

Leprous Lesions in other Organs

The last two chapters have been devoted to the clinical and histological features of skin and nerve lesions In this chapter we shall study the clinical features of leprous lesions in other organs and tissues taking in order the eyes the nose the mouth and pharynx the respiratory organs and the genital organs

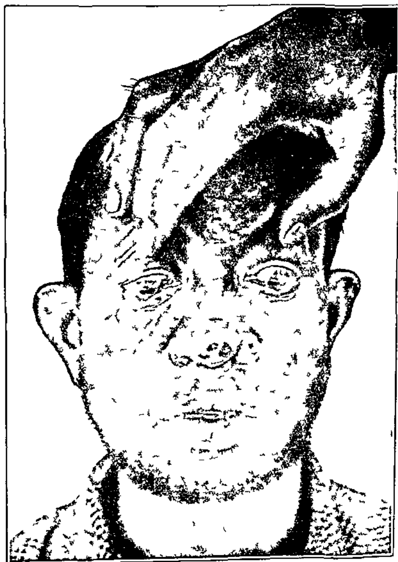
(1) *Lesions of the Eyes*

Ocular lesions are perhaps the most distressing and disabling that occur in leprosy There are two distinct forms that due to infection of the eyeball with *B lepræ* and occurring in serious cases of the cutaneous type and that secondary to nerve affection causing anæsthesia of the cornea and paresis of the eyelids

Lesions due to infection of the Eyeball The eye is seldom infected with *B lepræ* unless the surrounding skin of the face is also fairly heavily infected While the initial invasion of the bulb may be by vascular embolism the probability is that in the majority of cases infection spreads through the lymphatics from the surrounding skin of the face

Widespread infection of both the superficial and deep structures of the eye frequently takes place without giving rise to either subjective symptoms or clinical signs The first indication that the eye is affected may be during a generalized lepra reaction when examination shows swelling and congestion of the conjunctiva photophobia and partial interference with the reaction of the pupil to light and accommodation

In other cases invasion of the outer structures is more noticeable pterygium like swellings appear which invade the cornea or a ground glass like appearance resembling pannus spreads through the cornea generally affecting the upper sector and tending sooner or later to obscure the pupil



Fig

Result of panophthalmia in case of advanced leprosy of the cutaneous type

When the superficial structures of the eye are affected the deeper structures seldom escape The pupil dilates sluggishly or irregularly to atropine or may become entirely fixed In all cutaneous cases in which there is leprotic invasion of the face it is well to test occasionally the reaction of the pupil to atropine as irregular or sluggish dilation may indicate invasion of the deeper structures even in an otherwise apparently normal eye It is uncommon for the deeper structures to be affected if the sclera is exempt An apparently mild affection of the eye may be suddenly changed into a severe general ophthalmia by the onset of lepra reaction (fig 22)

Lesions secondary to nerve involvement In widespread lesions of the face occurring in cases of the neural or resistant type there is anæsthesia of the front of the eyeball as of the surrounding skin We have referred above to the effect of facial anæsthesia on the muscles of expression which lose their tone and show paresis This is most markedly seen in the muscles which close the eyelids The loss of the corneal reflex and the inability of the patient completely to close his eyelids remove the natural protection of the eyeball especially during sleep In consequence inflammation of the conjunctiva and even ulceration of the cornea are liable to occur unless special protective measures are taken (figs 23 and 29)

In severe cases ectropion may lead to eversion of the *punctum lacrymale* and to flowing of lachrymal fluid down the cheeks This may be caused either by paralysis of the *orbicularis* or as a consequence of fibrous contraction following resolution of adjacent diffuse or nodular skin lesions of the face When the region of the lachrymal sac is the site of deep leprous infiltration or when there is disease of the nose the lachrymal passages may be blocked and an abscess of the lachrymal sac result

(2) *Lesions of the Nose*

There is evidence in favour of the hypothesis that infection often enters the body through abrasions of the nasal mucosa The thinness of the nasal epithelium as

compared with that of the skin may permit the entrance of *B lepræ* especially when irritation leads to scratching with the finger nail

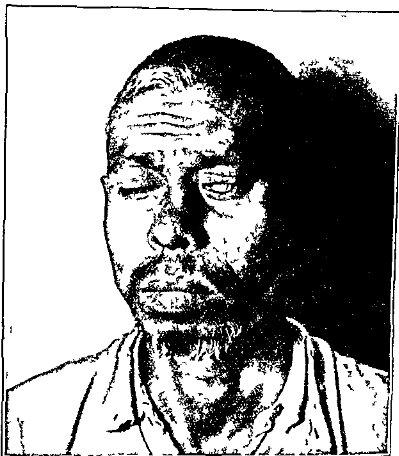


FIG 5
Lagophthalmos of left eye in leprosy of the neural type

All the degrees and types of lesions mentioned as occurring in the skin are likewise found in the nasal mucous membrane from the more superficial lesions in which bacilli cannot be found on bacteriological examination to grosser lesions with nodulation and ulceration

In cases of the neural type the nasal mucosa may be anæsthetic as is the skin Patients sometimes give the history of having ceased to suffer from nasal catarrh It

is not unlikely that in such cases the original infection has taken place through the nasal mucosa the bacilli being at first very few in number and forming a lesion analogous to the ascending nerve lesion of the skin in which also bacilli are not found as a rule on bacteriological examination The nasal mucosa in such cases is lighter in colour and dry the normal bright red moist appearance being absent

In other cases there is a more massive infection of the nasal cavity The inferior turbinate may have a nodular raspberry like appearance Ulcers or the scars of old ulcers may be seen on the septum The blocking of the nasal passages with dried muco purulent crusts may cause considerable distress to the patient Perforation and destruction of the cartilaginous septum may occur owing to the cutting off of its blood supply or to ulceration accompanied by secondary infection Leprosy differs from syphilis in seldom destroying the bony septum Flattening of the nose is due partly to loss of the cartilaginous septum but chiefly to fibrous contraction following ulceration inside the nasal cavity

(3) *Lesions of the Mouth and Pharynx*

Lesions of the lips are not uncommon as an extension from those of the skin of the face though they are rare as primary lesions Nodules frequently appear at the outer margin of the lips Contraction following severe lesions in and around the lips may lead to partial stenosis of the orifice

Nodulation of the tongue is common in advanced cases of the cutaneous type

The palate may be the site of either diffuse or nodular lesions The soft palate and the fauces may become ulcerated owing to the breaking down of leprous tissue cicatricial contraction following the healing of ulcers may cause partial obstruction of the fauces Partial obstruction of the air passages may also be caused by contraction following the healing of ulcers in the region of the epiglottis and false vocal cords The latter obstruction may be so severe

as to necessitate tracheotomy (fig 24) Perforation of the palate sometimes occurs in leprosy, but it is generally the



Fig 24
Tracheotomy in leprotic obstruction of the larynx

result of accompanying syphilis Probably the pharynx is most commonly infected by lymphatic spread from the nasal mucous membrane

Where there is much fibrosis and scar tissue resulting from healed ulcers in the nose and mouth the senses of taste and smell may be partially or wholly lost In neural cases the lingual nerve may be affected and the sense of taste impaired The tongue and palate may appear deeply pigmented owing to the absorption of leprotic tissue The voice in leprosy is often husky as the result of the laryngeal affection There may be infiltration of the true vocal cords

(4) *The Respiratory Organs*

In advanced cutaneous leprosy the patient may cough up large quantities of purulent sputum containing large numbers of acid fast bacilli It is doubtful whether the lungs are involved to any considerable extent in leprosy and this sputum may have its origin in the bursting of leprous nodules of the trachea which along with the upper bronchi may be considerably affected by the disease In other cases the purulent discharge may be from the nose or pharynx A differential diagnosis from tuberculosis of the lungs is important as the latter disease not infrequently complicates leprosy Where doubt exists the diagnosis should be cleared up by injection of the sputum into guinea pigs which gives negative results with leprosy and positive with tuberculosis



FIG 25
Gynecomastia in three male lepers

(5) *The Genital Organs and Endocrine Glands*

There is reason to believe that in all cases of severe cutaneous leprosy the testes are affected The affection is both intertubular and intratubular According to Hansen when the affection is marked the bacilli penetrate into the seminal canals and lie grouped round the nuclei the epithelial cells being more or less filled with them The glandular tissue may be entirely destroyed and reduced to scar tissue As a result of this gynæcomasty is a not uncommon condition in male lepers (see fig 25) The rudimentary mammary gland develops under hormonic stimulation following on suppression of testicular endocrine functions The breasts may become the size of an orange or even larger and may be the seat of repeated attacks of pain at irregular intervals and lasting for some days analogous to the menstrual cycles of the breast in woman

Besides these heterosexual characteristics the eunuchism of leprosy is followed by other changes in the correlations of the endocrine system which unless corrected may have a depressing effect on the physical and mental condition of the patient

Leprous invasion of the ovaries has been described but we are not aware of any clinical evidence of their being affected Likewise the suprarenals and other endocrine glands have sometimes been found at autopsy to be involved though there is little or no reason to suppose that their functions are interfered with by such involvement

CHAPTER IX

Complications of Leprosy

(1) *Secondary Neural* Lesions of the Limbs*

We have mentioned that in areas of skin which are or have been infected with *B lepræ* sensory and trophic changes occur which are most marked in cases of the resistant or neural type These changes are *primary* and result from tissue reaction to local infection of the skin and of small sensory nerve branches

Sensory and trophic changes also occur in parts which have themselves escaped infection as a secondary result of disease in the larger nerves supplying these parts (fig 26) These *secondary* lesions therefore correspond more or less accurately to the distribution or part of the distribution of the affected nerve or nerves They tend to be of the acroteric or glove stocking type affecting first the distal parts of the limbs and later the more proximal Thus if the ulnar nerve is affected anæsthesia begins in the little finger and spreads upwards

As has been mentioned above pressure on nerve fibres is apt to be accentuated when the nerve passes through unyielding structures such as bone or thick fibrous tissue which nip the swelling nerve Or again the fibrous covering of the nerve (epineurium) may become thickened through its reaction to leprous infection and may thus

* We use the term secondary neural *as applied to lesions* in a wider sense than that given under *classification of cases* in Chapter XIII There the term *as applied to cases* is restricted to neural cases that were formerly cutaneous but from which the active leprotic lesions have disappeared In these cases secondary neural lesions are the most prominent feature but we consider that the term as referring to lesions may be logically applied in the wider sense defined here

constrict the delicate nerve fibres Especially is this so when as occurs in all newly formed connective tissue

DIAGRAM OF
ASCENDING NERVE LEPROSY

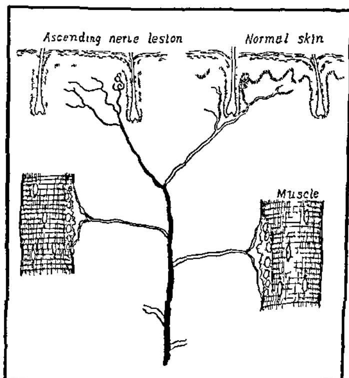


FIG 26

Diagram illustrating the spread of infection from a skin lesion up the nerve and consequent interference with the function of nerves supplying healthy skin and muscle

contraction takes place Allergic reaction in an affected nerve may bring on very rapid secondary changes

Secondary neural changes may be classified as follows —

(a) *Sensory* Anæsthesia to light touch analgesia loss of heat and cold sensation paræsthesia a feeling of heaviness numbness tingling pain Plotting out the anæsthetic areas of a

limb will often show primary and secondary lesions lying adjacent to or overlapping one another

(b) *Trophic* anidrosis may affect the greater portion of the limbs and be accompanied by compensatory hyperidrosis of the face and trunk (see fig 40) depilation occurs only to a limited extent in secondary lesions and is often

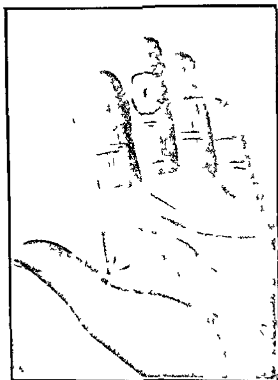


Fig 7
Blisters of the hand in neural leprosy

associated with local infection of the skin formation of blisters and bullæ due to trophic changes in the skin and when the process is deeper destruction of the epithelium and superficial ulcer formation decalcification

thinning and caries of bones arthritis which is either dry or accompanied by copious formation of synovial fluid Bone and joint lesions may become septic causing inflammatory swellings of the hand or foot or chronic deep perforating ulcers (fig 28) The bones



FIG 28
Trophic perforating ulcer of the foot

of the fingers and toes are most commonly affected, but the tarsus and even the tibia and fibula may be affected in severe cases

Blisters blebs and ulcers are not infrequently the result of burns and other injuries following loss of the protective function of sensation

(c) *Motor* The small muscles of the foot and hand tend to become paralysed, the muscle fibres becoming changed into fibrous tissue which contracts and produces deformities Hence the well known claw hand (main en griffe)

(fig 29) The wasting of the small muscles of the foot also removes a protective agency and increases the tendency to perforating ulcers Drop foot (peroneal palsy) is a frequent lesion and drop wrist (radial palsy) occasionally occurs

(2) *Paresis of Facial Muscles*

We have already referred to the secondary neural lesions occurring in the face as the result of infection of the seventh cranial nerve to the paresis of the muscles of expression accompanying widespread anæsthesia of the



FIG 29
Advanced case of neural leprosy Note the claw like hand and the mask like expression

face and to the secondary changes liable to occur in the eyeball due to paresis of the eyelids and anæsthesia of the cornea (figs 23 and 29)

In severe cases the patient is unable to close the lips and saliva may dribble from the mouth (fig 30)



FIG 30
Advanced case of leprosy of the neural type Note paresis of mouth muscles and involvement of the ankle

All these contribute to the formation of the mask like facial expression so typical of neural leprosy

(3) *Intercostal Nerves*

A condition resembling herpes zoster not infrequently occurs in connection with the intercostal nerves It may be exceedingly painful and may last for several days or even weeks It takes the form of vesicles or blisters on an inflamed base and corresponds with the cutaneous distribu-

tion of one or more intercostal nerves Whether or not this is connected with infection of the posterior root ganglia is not clear (fig 31)



Fig 31
Herpes-like eruption in leprosy affecting the distribution of costal nerves

(4) *Lepra Reaction*

This condition also known as lepra fever is one of the commonest and most distressing complications of leprosy

It appears to be of an allergic nature as it comes on suddenly with acute inflammatory symptoms but without any corresponding increase in the number of bacilli in the affected parts

There are generally more or less severe febrile and other constitutional symptoms Some or all of the existing clinical lesions show sudden swelling and vascular engorgement New lesions appear as rose coloured nodules or macules and in severe cases there may be marked œdematous swelling of the surrounding parts Cutaneous and sub

cutaneous nodules may form pustules or abscesses which break down discharging pus rich in lepra bacilli either free or contained in pus cells chiefly of polymorphonuclear type In severe cases as the reaction subsides the lesions

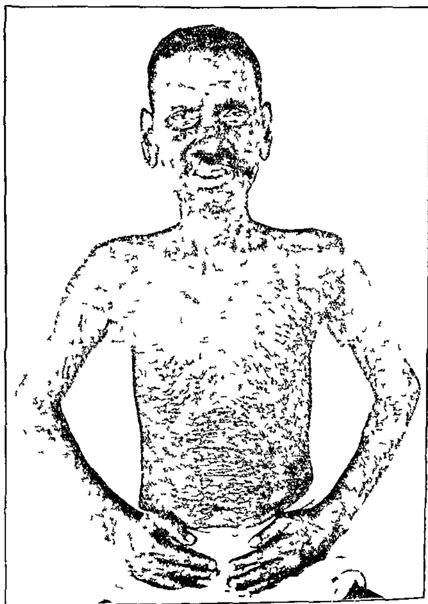


FIG 32
Deflated balloon like appearance on the subsidence of lepra reaction

remain covered with thick black epithelium which gradually desquamates or there is wrinkling of the skin like crushed tissue paper or a deflated balloon (fig 32)

Lepra reaction may last only a few days or may be prolonged for weeks or even months It may come on periodically at regular or irregular intervals fresh lesions or groups of lesions being affected on successive occasions

It occurs chiefly in cases of the cutaneous or mixed types and is generally associated with bad physical health It may be initiated by a complicating or intercurrent disease or by anything which tends to lower the patient s resistance

Lepra reaction also affects nerves containing large numbers of bacilli causing their sudden swelling accompanied by severe pain both in the main nerves and in their branches and distribution and also marked increase of motor sensory and trophic disturbances

A condition similar to lepra reaction can be produced in advanced or fairly advanced cases of leprosy by the administration of certain drugs notably the iodides In a patient with good general health the administration of a suitable dose of potassium iodide produces a febrile reaction with swelling and congestion of clinically apparent lesions and the appearance of new lesions The reaction however subsides rapidly within about forty eight hours as the iodide becomes eliminated from the body If however the patient s general health is not good or if he has become sensitized to leprosy the iodide reaction may precipitate *lepra reaction* of the allergic and continuous type

Other drugs notably mercurochrome if given in excessive or repeated doses have a similar though more delayed effect of a similar nature Mercurochrome in excessive or too frequently repeated doses will cause necrosis of large cutaneous and subcutaneous nodules with results which are difficult to control followed often by great lowering of the patient s health and the consequent net result of increase of the disease

There is reason to believe that in addition to the well known acute lepra reaction there is a chronic form in patients who have become sensitized to *B lepræ* In this there is a mild form of swelling of the lesions which continues for a considerable time Its existence is best demonstrated when the patient is desensitized by administration of small doses of heavy metals aniline dyes etc this is followed by rapid clinical improvement of the lesions but only up to a point beyond which improvement ceases

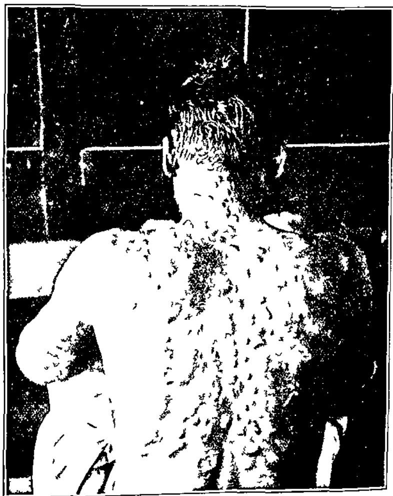


FIG 33

Widespread nodulation which appeared suddenly and again flattened out after a few weeks leaving only hypopigmentation There were but few lepra bacilli found in the lesions

There is another condition which in some respects resembles but should in our opinion be distinguished from *lepra reaction* (See Chapter V, Section 6.) This may conveniently be termed recovery or convalescence reaction. In contrast to the other this occurs in highly resistant patients whose general health has been temporarily lowered by some intercurrent cause during which bacilli



Fig. 34

Reacting tuberculoid lesion

This patient's face swelled up suddenly and again subsided after a few weeks. Leprosy was confined to the face.

have multiplied to a limited extent in skin and nerves. Recovery from this temporary debilitating factor may be followed by swelling and other inflammatory signs in skin and nerve lesions due to the restored power of the tissues to react and the increased number of bacilli calling forth

the reaction (see figs 33 and 34) This as mentioned above may in extreme cases cause caseation followed by abscess formation in the nerves and ulceration of the skin

Recovery reaction differs therefore from the ordinary *lepra reaction* in the following respects —

Recovery Reaction	*Lepra Reaction*
In resistant cases chiefly of neural type	In cases with weak resistance of mixed or cutaneous type
May follow recovery from debility	During debility
Few bacilli present in lesions	Many bacilli in lesions
Giant cells caseation and abscess formation in nerves	Lepra cells abscess formation of cutaneous nodules
It generally occurs once and there is a tendency for the inflammatory signs to clear up as the bacilli are eliminated by the tissue reaction	Tends to be repeated from time to time at regular or irregular intervals
Febrile and other systemic signs are slight or absent	Febrile and other systemic signs are well marked

CHAPTER X

DIAGNOSIS—NEURAL LEPROSY

The diagnosis of leprosy is based upon clinical bacterio logical and histological examination We have so far no serological test of any material value in the diagnosis of the disease



FIG 35
\ al m cular (tuberculoid) lesion of the ba k with raised red margin anæsthetic to light touch bacteriological examin tion negative

In neural leprosy the diagnosis is based chiefly on clinical signs and symptoms *B lepræ* are few and hard to find in the skin and bacteriological examination of the nerves is difficult to perform and seldom necessary

In cutaneous leprosy the clinical signs are of value but as sensory changes are less marked they are less to be depended on than in the neural type clinical examination should therefore always if possible be supplemented by bacteriological examination

In suspected cases in which the clinical signs are indefinite and repeated bacteriological examination of smears from the skin and nasal mucosa gives negative results smears from nerves and sections of biopsy material from

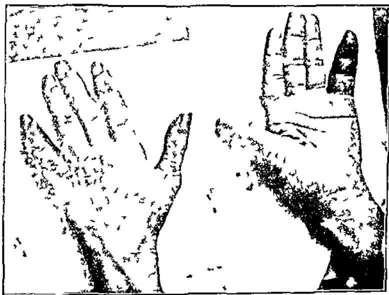


FIG 36
Neural macule of little finger of left hand (front and back)

skin or nerves may be of use in clearing up the diagnosis This is particularly so in many cases of leprosy in young children (*juvenile type*)

It has been explained in the last chapter that sensory and trophic changes in neural leprosy may be primary due to local inflammatory changes or secondary to involve-

ment of the supplying nerve In the former the lesion is generally in the form of a macule and more or less circular



Fig 37
Thick indurated neural macule of buttock with uniform thickness very chronic type

or where two or more macules have coalesced irregular in shape In the latter the lesion corresponds to the distribution or part of the distribution of one or more of the main nerves

(1) *Neural Macule or Tuberculoid*

The typical neural macule varies in size It may begin as a papule or nodule or appear as a macule several centimetres in diameter from the beginning As a rule it is small at first but tends to increase in diameter by centrifugal spread and may in the end cover a large area Most commonly the spreading margin is raised and

erythematous and the centre flat though the whole lesion may be equally raised and thickened (figs 35 36 37 38)



FIG 38
Multiple leprous macules of the neural (tuberculoid type) with raised margin and flat centre

Neural macules show the following sensory and trophic changes —

Anæsthesia to Light Touch —This may be examined for as follows —The patient is stripped as far as possible and blindfolded (fig 39) Sensation is tested by touching different points on the skin surface with a light object such as a feather or camel hair brush the patient being instructed to place his index finger exactly on the points touched Begin by touching normal skin When this has been done two or three times and the patient responds as indicated touch the suspected area His lack of response indicates anæsthesia to light touch To avoid error this should be

repeated the normal skin being used as a control In this way the anæsthetic area may be mapped out The degree

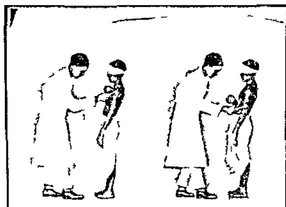


FIG 39
Method of testing f r anæ thes a to light tou h

of anæsthesia varies in different lesions and in different parts of the same lesion Definite anæsthesia to light touch is one of the cardinal signs of leprosy other conditions in which it is present are mentioned under differential diagnosis

Analgesia is often present even when anæsthesia to light touch is absent Test as follows —Blindfold the patient take two pins of the same size and sharpness one in each hand prick the skin inside the suspected area and simultaneously using equal pressure prick the skin either immediately outside the area or at the corresponding point on the other side of the body Ask the patient which is the more painful By repeating the test several times with slight changes in the position of the pricks differences in pain sensation can be elicited with a fair amount of accuracy

Heat and Cold Sensation can be tested similarly by touching the skin with test tubes containing hot and cold water and questioning the patient regarding the temperature

Depilation is another common occurrence The hair breaks off at the point where it emerges from the hair follicle leaving a rounded bulbous end If this be seized with a depilation forceps a long curled up hair may be extracted with parts of the follicle adherent

Anidrosis is also present as evidenced by the dry feeling when the finger is passed over the affected skin



FIG 40

Photograph illustrating anidrosis in leprosy The surrounding skin shows the papules of prickly heat while the central area being leprous and therefore anhydrotic has escaped

surface and by the absence of sweat droplets on the lesion when the patient is sweating profusely as the result of heat exercise or the administration of pilocarpine (fig 40)

Keratosis is often present in the form of thickening of the epithelium (hyperkeratosis) or scaling of the surface epithelium (parakeratosis) The skin markings are larger and coarser and the surface has a shiny appearance

Hypopigmentation is a usual feature in neural macules most conspicuous in dark skins It is often masked especially at the margin by vascular congestion and erythema

Thickening and tenderness of supplying Nerves —Small nerve branches supplying the part may sometimes be felt on palpation or the main nerve may be thickened and tender If the suspected skin is struck sharply with the finger or the side of the hand or with some blunt instrument tenderness or shooting or tingling pain may be elicited this being absent when the corresponding area is struck on the other side of the body

Bacteriological findings —Smears should be made from the skin but *B lepræ* are as a rule found in the typical neural macule only with great difficulty

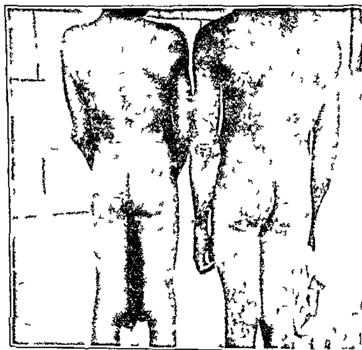


FIG 41

Leprosy (tuber loid) t the left Psori sis case placed long d for comp ri on

(2) *Conditions to be differentiated from the Neural Macule*

(*a*) *Psoriasis*—Sensory changes are absent Removal of scales leaves small bleeding points Depilation and anidrosis are absent (fig 41)

(*b*) *Tinea*—Various forms of ringworm have to be differentiated The presence of the fungus and the absence of sensory and other neural changes generally make the diagnosis easy except in very slight lesions Irritation of the skin though sometimes present in leprous lesions is as a rule much more marked in ringworm Tinea is a very common complication of leprosy and lesions of the two diseases often lie side by side or even overlap *Tinea versicolor* and *tinea cruris* are the two commonest forms (see fig 42)



FIG 4

Tinea cruris resembling leprosy

(*c*) *Seborrhœal dermatitis* has not infrequently been mistaken for leprosy especially by inexperienced persons who have or fear they have been exposed to leprous infection and who have a tendency towards lepraphobia'

(*d*) *Syphilis* may often closely
and other lesions of leprosy Th
changes and the readiness with wh
to treatment generally make the d



must be remembered however that both diseases are not infrequently present at the same time and that a positive serological test does not exclude leprosy (see fig 43)

(*e*) *Yaws* (framboesia) and its later development *gangosa* are not uncommonly mistaken for leprosy The absence of changes in sensation of thickened nerves and of acid fast organisms are sufficient to make the differential diagnosis and *Treponema pertenue* may in early cases be found on microscopic examination The old scars of yaws in the form of depigmented patches often closely simulate slight leprous lesions Therefore in places where yaws is common a diagnosis of leprosy should not be made unless either definite *B lepræ* are found in the skin or definite anæsthesia to light touch is present The thickened skin of crab yaws may give a semblance of anæsthesia The



FIG 44
Crab yaws

therapeutic test should always be used though very chronic cases of yaws do not always improve under treatment (see figs 44 and 45)



FIG 45
Florid yaws in child

(*f*) *Dermal leishmaniasis* —This has frequently been mistaken for leprosy which it may sometimes closely resemble Sensory changes are absent When affecting the face it tends to concentrate round the nose and mouth The macules are smaller and have less tendency to spread or to form a raised margin than those of leprosy The history of having suffered from kala azar or of having lived in an area where this disease is endemic may be of value The finding of Leishman Donovan bodies will in many cases clear up the diagnosis Here again both diseases are occasionally present at the same time (see fig 53)

(g) *Tuberculosis* —*Lupus vulgaris* is liable to be mis taken for the neural macule In both diseases a few acid fast bacilli may with difficulty be found in smears or sections and the histological examination of the skin shows certain characteristics in common Lupus has generally though not always a greater tendency to scar formation than leprosy The main point in differential diagnosis is the absence of nerve affection and sensory signs In leprous macules resembling lupus the supplying nerves will almost certainly be affected

(h) *Lupus erythematosus* —Here again the absence of sensory signs and nerve thickening and negative histological findings are sufficient to make the differentiation clear

(i) *Leucoderma* is in India and other countries often mistaken for leprosy Depigmentation is as a rule more complete and sensory signs are absent It should be remembered that a complete depigmentation of the skin is often found in the sites of healed leprous ulcers

(j) *Injuries* such as burns may leave anæsthetic scars Anæsthesia may be caused by injuries to or pressure on nerves The writer has not infrequently been consulted in such cases as to the possibility of leprosy

(k) Various dietary deficiencies food poisons etc give rise to conditions liable to be mistaken for leprosy both on account of clinical appearances such as keratosis and discolouration and because of doubtful sensory changes Among these are pellagra and beri beri like conditions found in primitive peoples

(3) *Secondary Neural Lesions*

We have already dealt with the clinical features in Chapter VII and in the first section of Chapter IX

The signs of secondary neural lesions may be divided into sensory trophic motor and vaso motor These signs are not due to leprous infection of the parts involved but are secondary to involvement of the supplying nerves They are most marked in the distal portions of the limbs and we shall describe these first

Secondary neural lesions in the upper and lower limbs tend to be *acroteric* in nature

In early cases the ulnar side of the hand and the little finger are most commonly affected There may be slight loss of sensation (tested as mentioned above) a feeling of heaviness in the part and inability to straighten the little finger (see figs 36 and 71) The ulnar nerve should be examined for thickening and tenderness in the following way Both arms are stripped to well above the elbow The forearms are slightly bent to an angle of 140° and with the patient standing facing the examiner both ulnar nerves are palpated simultaneously with the forefingers Thus slight differences of thickening may be noted It must be remembered that normal nerves vary considerably in their apparent thickness on palpation and in doubtful cases stress should be laid on a careful comparison of the two sides The nerve should be traced with the finger from behind the elbow to at least half way up the arm Slight pressure on the thickened nerve should elicit local tenderness and also the feeling of tingling in the hand

The more the nerve is involved the wider the anæsthesia spreads to the limits of the ulnar nerve supply The small muscles of the hand show signs of atrophy with flattening of the thenar and hypothenar eminences and the appearance of linear hollows between the metacarpal bones The fingers become bent with hyper extension at the meta carpo phalangeal joints and flexion at the interphalangeal joints resulting finally in the condition of claw hand (main en griffe) (fig 29)

A useful test in early cases is to make the patient alternately adduct and abduct the little fingers of both hands simultaneously Difficulty in adduction will be noticed on the affected as compared with the healthy side

There is a tendency to the formation of blisters and ulcers especially on the affected fingers which is associated with interference with trophic supply and often excited by burns or slight injuries As decalcification and other trophic changes take place in the bones the fingers tend to

become thinned and *shortened*, with or without septic complications till in extreme cases the fingers may almost entirely disappear

Although the ulnar nerve may at first swell to a great thickness contraction of fibrous tissue may later reduce it to a fine thread thinner than the normal nerve this may be an important point to remember in making a differential diagnosis

The radial and median nerves are also frequently affected either separately or along with the ulnar The formation of a ganglion at the back of the wrist is a not infrequent complication of median nerve involvement The muscles of the forearm may become atrophied due either to involvement of the supplying nerves or more frequently to disuse of the arm on account of the tenderness of the ulnar nerve

Similar conditions occur in the lower extremities, the common peroneals being the most commonly affected nerves To test these straighten the patient s knees and place the thumbs on the patella and the middle and ring fingers of each hand on the corresponding peroneal nerve as it curves round the back and outer side of the neck of the fibula The thickened branches of the nerve may also be felt in the front of the ankle and over the proximal part of the dorsum of the foot The sural nerve is also sometimes affected and may be felt in the dorsum of the calf Trophic ulcers of the foot have already been described in the first section of Chapter IX

(4) *Conditions to be differentiated from Secondary Neural Lesions*

(*a*) *Syringomelia* —The absence of nerve swelling and tenderness is important Analgesia and loss of heat and cold sensation are accompanied by retention of sensation to light touch and the sweat function The absence of other indications of leprosy and the presence of spastic signs and fibrillary tremors may help in differentiation

(*b*) *Cervical rib* —Here X-Ray examination should clear up the diagnosis Nerve thickening is absent There is

loss of tactile and thermic senses but retention of pain sense



FIG 46
Raynaud s disease

(*c*) *Raynaud s disease* has often been confused with leprosy because of the trophic changes present In a case of leprosy with gangrene of the digits resembling Raynaud s disease there is very marked anæsthesia of the whole foot or hand whereas in the latter disease there is anæsthesia only of the gangrenous parts and pain is a much more marked symptom (fig 46)

(*d*) Superficial glove anæsthesia has been found as the result of *diphtheritic neuritis* The history and the absence of thickening of the nerves leave no difficulty in making the differential diagnosis

(*e*) Tenderness of superficial nerves especially the ulnar due to *neuritis of septic origin* is not infrequently a cause of personal alarm to doctors and others engaged in the treatment of leprous patients There is however seldom thickening of the nerve nor is there anæsthesia and attention to some septic focus connected with the teeth nasal sinuses bowel etc will generally clear up the condition

(*f*) In hypertrophic interstitial neuritis (Dejerine Sottas disease) there is thickening of the nerves This condition if it occurs in childhood is generally connected with a family history though this may be absent in cases occurring first in adult life The nerves most commonly affected are the ulnar internal cutaneous of the forearm saphenous and superficial cervical The thickening of the nerves may be so great as to render them conspicuous to the naked eye Sensory and trophic signs are similar to those in nerve leprosy as there is atrophy of the distal segment of the upper limb with claw hand Club foot and talipes cavus are described as occurring in the lower limb rather than the trophic ulcers and drop foot so familiar in leprosy The diagnosis of neural leprosy is simple in cases in which anæsthetic macules are present When these are absent and when bacteriological examination of scrapings from the thickened nerves is negative the differential diagnosis may be more difficult If doubt exists sections of a small thickened nerve branch should clear up all doubt as the pathology of hypertrophic interstitial neuritis is very different from that of nerve leprosy There is hypertrophy of the peripheral nerves and in the spinal ganglia Masses of tissue may be present with or without nuclei arising from Schwann s sheath Associated changes may be found in the anterior horn cells and in the posterior columns of the spinal cord This disease is very rare

(*g*) *Neuro fibroma* (von Recklinghausen's disease) may sometimes resemble leprosy in respect both of nodule formation and of nerve thickening. Bacteriological examination of the nodules however fails to show acid fast organisms and there are no sensory changes such as are present in leprosy.

(*h*) *Neuritis of the lateral femoral nerve*.—(Bernhardt's syndrome) This may result in sensory changes in the antero lateral region of the thigh. The size of the affected area varies from a few inches to almost the whole length of the thigh. In slight cases there is a feeling of numbness and slight loss of epicritic sensibility. In more severe cases there is a feeling of gnawing, burning or pricking and complete loss of sensation on light touch or pricking

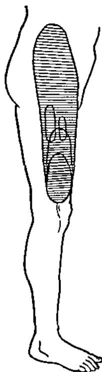


FIG 47

Bernhardt's syndrome. The oval markings indicate the anæsthetic areas in different cases.

with a pin in the affected area There is no depila tion or keratosis such as would be present if the case were one of leprosy The condition tends to yield to protein shock and other forms of pyrotherapy (fig 47)

(i) The deformities caused by yaws crab yaws and gangosa may sometimes simulate secondary neural as well as other forms of leprosy The absence of anæsthesia and nerve thickening is the chief point of differentiation

(5) *Permanent Lesions*

As is mentioned on page 29 leprosy is often self-healing but permanent lesions may remain in the form of scars deformities and sensory changes Patients with only these lesions should be clearly distinguished from those with *active signs* as defined on page 130

CHAPTER XI

Diagnosis—Cutaneous Leprosy

Lesions may be macular diffusely infiltrated nodular or may consist of combinations of these The chief diagnostic point is the finding of *B lepræ* in the skin

(1) *The Cutaneous Macule* (figs 48 and 49)

This in some respects resembles the neural macule described in the last chapter The main differences are the less degree of sensory and trophic impairment and the comparative ease with which bacilli are found in smears and sections As a general rule cutaneous macules are less indurated and as the margin blends more with the surrounding skin they tend to be less conspicuous and less clearly defined The leprolin test (see Appendix III) gives as a rule a negative or only slight reaction

(2) *Diffuse Infiltration*

This occurs in patients with low resistance and long standing lesions Infiltration of the skin takes place from numerous foci which spread and coalesce but the cellular reaction is comparatively slight and macules do not appear

The infection may be confined at first to the sub papillary plexus and its branches and to the more superficial portion of the skin Large areas of the skin may thus become infiltrated without attracting the attention of the patient or physician Later general thickening may take place as the bacilli increase in number spread deeper and induce a greater degree of tissue response due to their large numbers This thickening produces a smooth shiny appearance on account of the stretching and flattening of the epithelium and at the same time a mosaic like pattern

may appear (see fig 50) the skin markings standing out more distinctly as the inter follicular areas are pressed



FIG 48

Cutaneous macules rich in lepra bacilli

outwards by the granuloma Corrugation occurs where the skin is bent at an angle hence *leontiasis* the lion like appearance where there is thickening in the supra orbital region (fig 51)

In diffuse infiltration there is destruction of the larger and deeper hairs such as those of the eyebrows but depila-

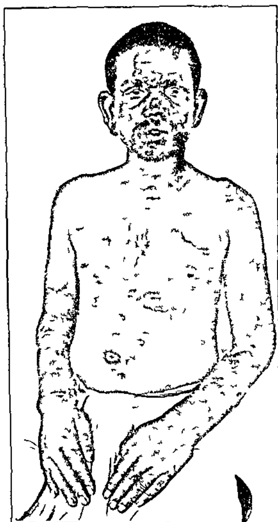


FIG 49

Th k macule of the ut neous type rl h in l p a ba lli
te th nodul tion of th face nd

tion is not as marked as in the neural (resistant) type of lesion Keratosis is as a rule absent or at least not as

marked as in neural lesions In cases of mixed type with secondary neural affection of the limbs the sweat function

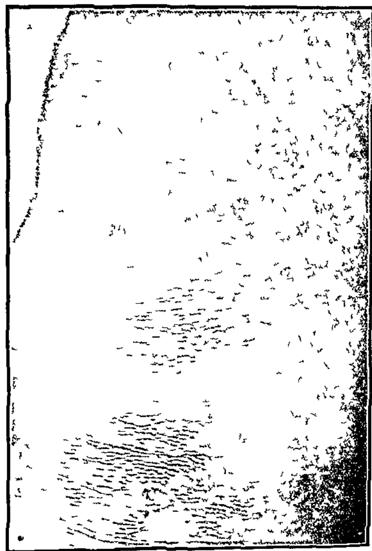


FIG 50
Diffuse lesion causing mosaic like pattern

may be excessive in the face and trunk even in infiltrated areas (see fig 52) this hyperidrosis compensating for the loss of sweat function in the limbs

(3) *Nodulation*

This may occur in otherwise normal skin but it is most common in previously infiltrated areas Nodules may be



Fig 51
Adv nced nodulation of th f

soft and vascular or hard and fibrous they may be single or multiple They occur most commonly on the parts of the body which are exposed and most liable to injury such as the face and ears the hands and feet the elbows and knees Crops of evanescent nodules may come and go especially during lepra reaction

(4) *The Differential Diagnosis of Skin Leprosy*

This must depend on finding the causal organism Dermal leishmaniasis and diffuse adenomata may give appearances clinically indistinguishable from cutaneous leprosy (see fig 53)

Eunuchism has often been mistaken for leprosy due to the absence of the eyebrows and the sleek shiny appearance of the skin

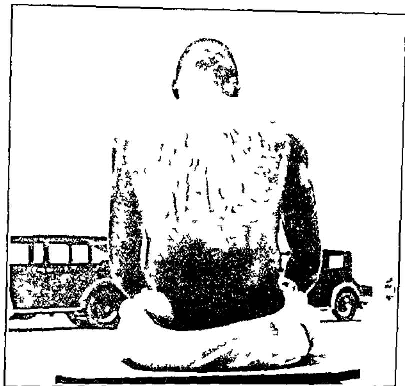


Fig 52
Hyperidrosis compensating the anhydrosis of the limb in a case of neural leprosy

(5) *Juvenile Leprosy*

We discuss in Chapter XIV the factors determining resistance and the methods of estimating them We mention that the resistance of young children to leprous infection is comparatively low In consequence of this the infection is able to spread widely throughout the body without inducing marked tissue reaction In some cases clinical signs are apt to be only slight Macules or slightly hypopigmented areas appear and disappear There may be doubtful neural symptoms such as thickening of the ulnar nerves or slight anæsthesia but there are often insufficient grounds for making a clear diagnosis In

doubtful cases history of contact with infection must be taken into account but it may be necessary to suspend



FIG 53

Dermal leishmaniasis resembling leprosy

diagnosis and keep the case under observation until more definite signs appear

It is difficult to classify such cases under the cutaneous type as the chief characteristic—a positive bacteriological examination—is absent also the cardinal signs of neural leprosy—anæsthesia and thickened nerves—are not definite We use the term juvenile leprosy as the condition appears in children before or at adolescence

Examination of sections of biopsy material may help to clear up the diagnosis but cellular proliferation and thickening round the vessels of the subpapillary plexus

such as is seen in these cases is also found in other cutaneous diseases

The leprolin test gives a slight or negative result

Even when there is a clear history of prolonged contact with infection care should be taken in making a definite diagnosis in this form of the disease In North India hypopigmented lichenous patches resembling juvenile leprosy may appear on the face and other parts of the body especially in the winter time These are often due to endocrine deficiency and may clear up on administration of thyroid or disappear when the weather becomes warmer

CHAPTER XII

METHODS OF MAKING AND EXAMINING SMEARS FOR BACTERIOLOGICAL EXAMINATION

Various methods of obtaining material for examination of *B lepræ* have been suggested such as lymph node puncture or aspiration of fluid from blisters raised by CO_2 snow and other escarotics We recommend as the standard method the examination of smears taken direct from the skin and the mucous membrane of the nose If these are negative other procedures are not likely to give positive results

(1) *Taking the Skin Smear*

Smears may be taken from the skin either by the snip or the scraped incision method The former is slightly more thorough than the latter but it is more

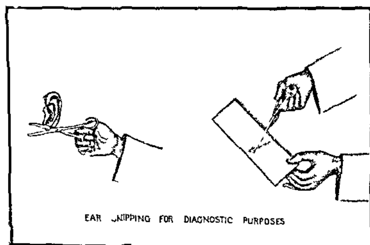


FIG 54

painful leaves a scar and cannot be repeated as often as the latter without serious inconvenience to the patient

Snip Method —After cleaning the part a small piece of skin is removed with a scissors curved on the flat or with a scarp scalpel The cut must be deep enough to draw blood The material taken is either rubbed (raw surface down) on the slide or the pulp is scraped off the epithelium with a knife and smeared on the slide (fig 54)

The *Scraped Incision Method* is thus described by Wade — Pinch up the skin in a fold applying enough compression to stop or minimise bleeding When it cannot be actually picked up compress it laterally as much as possible With a properly cleansed scalpel of suitable style and size make a small but real cut 5 mm or so long and deep enough (about 2 mm) to get well into the infiltrated layer If blood or lymph exudes in any quantity



FIG 5

Method of scrap ng out lep ou m t rial after cutting tl e skin

wipe it off With the knife blade turned transversely to the line of the cut scrape the side and bottom of the cut

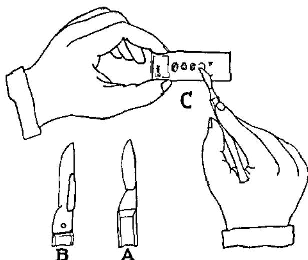


FIG 56
Method of m king sm

repeatedly and with sufficient vigour to obtain a little actual tissue pulp from below the epidermis With the knife transfer the small amount of material obtained to a microscopic slide and make a uniform moderately thick smear over a small area (see figs 55 and 56)

Whichever method is used compression with a small piece of cotton wool is generally sufficient to stop the bleeding otherwise wool with Tr Benzoin Co may be applied

The selection of the site to be examined is important The most marked and indurated lesion or part of a lesion should as a rule be chosen such as a nodule or the raised margin of a macule In cases with diffuse infiltration and with no outstanding lesion the edge of the lobule of the ear may be conveniently chosen as it is a particularly common site of infection and it is easy to hold between the finger and thumb while taking the material

The skin should be thoroughly rubbed with alcohol or ether before taking the material not only to render it

aseptic but also to remove any saprophytic acid fast bacilli that may be lying on the surface The knife or scissors should be flamed before a second use as acid fast bacilli may adhere to the blade and are not necessarily removed at once by wiping or boiling We have seen mistakes repeatedly made by neglecting this precaution

In patients in whom cutaneous leprosy is suspected failure to find bacilli in one smear does not justify a negative diagnosis When necessary multiple smears should be made taking material from different sites Several smears may be made on one slide a note being kept of the part from which each was taken It must be remembered that the number of bacilli varies considerably in different cases so that while in one smear massive infection may be found in another the whole slide may show only a few bacilli It is well to make smears of standard size and thickness so that the degree of infection may be at least roughly estimated

(2) *Taking Material from the Nares*

The examination of the nasal mucous membrane is almost as important as that of the skin It occasionally gives positive bacteriological findings when the skin is apparently negative A thin sharp pointed knife (such as a tenotomy knife) is used Material should be taken from the septum or the inferior concha If there is an ulcerated surface slight scraping is sufficient otherwise a small piece of mucous membrane should be scraped off In cases improving under treatment it may be necessary before declaring the nose negative to anæsthetise the mucosa and using a speculum remove material from the upper part of the septum at least $1\frac{1}{2}$ inches above the orifice A cotton swab should not be used in making the smear as acid fast or partially acid fast organisms are frequently present on the surface of the mucosa and have not infrequently been mistaken for *B lepræ* If a sharp instrument is used and a small piece of mucosa removed this mistake is less likely to occur

(3) *Staining Slides (Ziehl Neelsen Method)*

(*a*) Fix with heat taking care not to char the smear

(*b*) Use the following stain —

Basic fuchsin	1 part	Grind thoroughly with pestle in mortar
Alcohol (95 per cent)	10 parts	
Solution of carbolic acid (1 in 10)	90 parts	

Place on the slide a square of filter paper large enough to cover the smear or smears and pour the stain on to the filter paper This prevents its spreading on the slide Heat till it steams and allow it to remain for 5 to 10 minutes or stain cold for from $\frac{1}{2}$ to 1 hour taking care the stain does not dry

(*c*) Decolourize for a few seconds with 10 per cent solution of strong sulphuric or nitric acid in water The tissues become yellow

(*d*) Wash well with water The tissues regain a faint pink tint If the colour is distinctly red the decolouration is insufficient and acid must be re applied

This process should be repeated till only a slight red tint remains It is well sometimes to stain two slides decolourizing the one more than the other This ensures that in one slide at least only the *B lepræ* remain stained partly acid fast saprophytes so often present in nasal smears being eliminated In the other the *B lepræ* will retain a brighter colour and more are likely to appear Finally wash well in water to remove all acid

(*e*) Contrast stain with a saturated watery solution of methylene blue for 2 or 3 minutes

(*f*) Wash well with water and dry

(*g*) Examine with the $\frac{1}{12}$ inch oil immersion objective either direct or after mounting with acid free Canada balsam

It must be remembered that leprosy bacilli are less acid fast than tubercle bacilli

(4) *Examination of Slides*

In searching for bacilli an oil immersion objective and a fairly low ocular should be used a higher ocular being substituted if necessary for further examination of doubtful organisms

At least 100 fields should be examined before a slide is declared negative A convenient way to denote the number of bacilli found is to write the largest number found in any field as the numerator and the number of fields examined as the denominator If more than 10 bacilli are found in any field then write M as numerator Thus $\frac{5}{1}$ = 5 bacilli was the largest number found in any field $\frac{M}{1}$ = more than 10 bacilli were found in at least one field $\frac{3}{50}$ = 3 bacilli were found after searching 50 fields In this way a rough record can be kept of the progress of the patient at successive examinations

(5) *Histological Examination*

The examination of sections of skin and subcutaneous tissue obtained by biopsy may be resorted to in some doubtful cases though this is seldom necessary For the purpose of diagnosis this is only justified in cases in which bacteriological examinations are negative and the clinical signs are doubtful In such cases there is as a rule to be seen in sections of the skin little that is clearly pathognomonic of leprosy as compared with other skin diseases In slight lesions the principal feature which distinguishes leprosy from other diseases is the infiltration of the nerves and it is important therefore to examine deep sections containing subcutaneous tissue and to examine especially the subcutaneous nerves for signs of granuloma

In cases with doubtful thickening of a superficial nerve and in which a clear diagnosis cannot otherwise be arrived at it may be advisable to examine a nerve smear Cut down on the nerve incise the epineurium longitudinally then with the sharp point of a knife gently scrape the bottom of the incision and tease out on a slide the few strands of nerve fibre thus removed If the case is one of leprosy

acid fast bacilli may be found lying on and between the fibres (fig 57)

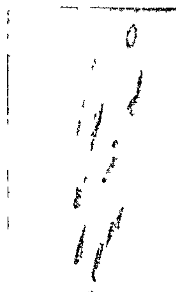


FIG 57

Nerve fib r mo d by craping thi k ned nerve aft dividing epin urium
Not b illi lying on the fibres

CHAPTER XIII

Classification

The classification of leprous cases is of considerable importance but we have to confess that there is as yet no very satisfactory nomenclature or division of the various types

The classification adopted at the Leonard Wood Memorial Leprosy Conference in 1931 is as follows —

Neural (N) —All cases that show evidence of actual or previous nerve involvement i e alterations of sensation with or without changes in pigmentation and circulation trophic disturbances or paralysis and their consequent results atrophies contractures ulcerations These are not accompanied by leprotic changes in the skin

Cutaneous (C) —All cases showing leprotic lesions in the skin Such cases may or may not show at any given time clinical manifestations of nerve involvement

Neural 1 (N 1) —Slight neural cases with one or a few small areas of disturbed sensation which may or may not show alterations of circulation or pigmentation paralysis or trophic disturbances of minor degree

Neural 2 (N 2) —Moderately advanced neural cases with extensive or numerous areas of disturbed sensation not confined to any one part of the body with paralysis or and visible evidence of trophic disturbances marked depigmentation moderate atrophy keratosis bullæ etc

Neural 3 (N 3) —Advanced neural cases with more or less extensive areas of anæsthesia and marked motor and trophic disturbances marked paralysis atrophies contractures trophic ulcers and mutilations

Cutaneous 1 (C 1) —Slight cutaneous cases with one to a few leprotic macules or a few small areas of infiltration or nodules

Cutaneous 2 (C 2) —Moderately advanced cutaneous cases with numerous leprotic macules or fairly numerous or marked areas of infiltration or nodules frequently with lesions of the mucosa

Cutaneous 3 (C 3) —Advanced cutaneous numerous or very marked leprotic lesions in varying stages of development or retrogression usually with lesions in the mucosa.

In all cutaneous types there may be varying degrees of neural involvement and such cases should be recorded to indicate the degree of this involvement as for example C 2 N 1

Secondary Neural—Neural cases that were formerly cutaneous but from which the active leprotic lesions have disappeared

It will be noticed that it is difficult to place two of the commonest and most important types of leprosy in this classification

The neural macule as described above does not conform to the description of neural leprosy But it is necessary at present to include it under this type as we have shown that in such cases the main seat of infection is in the nerves and the main signs and symptoms are neural

It is necessary to make a distinction between the *neural* and the *cutaneous* macule Probably the simplest method is to term those *neural* in which routine bacteriological examination is negative and anæsthesia to light touch is well marked and those as *cutaneous* in which routine bacteriological examination is positive and anæsthesia to light touch absent Cases can then be classified according to their lesions as C or N and when both types are present or lesions show the characteristics of both types as C N

For practical purposes this is a useful division as cutaneous cases may be considered as possible sources of infection though necessarily in different degrees according to the number of bacilli while neural cases may be considered non infectious

It is also difficult to fit the condition we have termed Juvenile Leprosy into the classification and it is well to place this type in a separate class by itself (see Chapter XI Section 5)

The essential matter of distinction between cases of leprosy lies in the *resistance of the tissues of the body to M lepræ infection* It is the resistance that determines the spread of infection the degree of cellular infiltration and the extent and nature of affection in the skin and nerves It therefore seems only reasonable that in any future modification of classification there should be an attempt to assess the patient s resistance

CHAPTER XIV

Resistance to Leprosy

Having diagnosed and classified the case the next duty of the physician is to form as accurate an estimate as possible of the patient's resistance to the disease and to assess various factors which may be responsible for lowering his resistance

This is necessary before satisfactory treatment can be undertaken as the main object in treatment consists in improving the patient's health and thereby improving his resistance to the disease Special treatment undertaken when the patient's general condition is weak is more likely to be harmful than beneficial

(1) *Principal Factors Determining Resistance*

We have already discussed in Chapter V the results in leprous lesions of raised and lowered resistance The principal factors connected with lowered resistance are tender age debility and gross infection with *B lepræ* on the other hand slight infections with *B lepræ* may tend to raise it

It has long been known that children are more susceptible to leprous infection than adults Children living with leprous parents show an incidence of 40 to 50 per cent whereas conjugal infections are variously estimated at 2 to 5 per cent The leprolin test (see Appendix III) also indicates lower resistance in children The greatest danger seems to be during the first year of life Juvenile leprosy has already been described in the last section of Chapter XI

Debility is the second factor occasioned by accompanying or intercurrent diseases by malnutrition or by anything else which impairs the general health Leprosy

itself apart from complications does not as a rule cause debility to any marked extent but during its prolonged course there is ample time and opportunity for debilitating factors to destroy or temporarily impair the patient s resistance

While small infections with leprosy appear to increase the power of the tissues to react to and to phagocytose lepra bacilli in their neighbourhood increase of bacilli in the body beyond a certain amount appears to have the opposite effect From this we may conclude that the former produces a form of specific resistance to *B lepræ* but the latter is accompanied by tolerance for the organism and by diminished resistance Thus in cutaneous cases we often have a vicious circle formed the increase of bacilli lowering resistance and this again favouring a still greater multiplication of bacilli Hence the great importance of arresting the disease before the threshold is passed and the tissues acquire a state of tolerance

(2) *Estimation of the Patient s Resistance*

The following points have to be noted in examining the patient —

(*a*) The duration of the disease as ascertained from the history and the rate at which it is increasing or diminishing Lesions may remain stationary for years and on the other hand they may spread with alarming rapidity This depends not on any difference in the virulence of the organism but on the degree of resistance of the patient to the disease

(*b*) Along with the duration of the disease must be considered its extent and the number size and nature of the lesions

(*c*) The physical and general health of the patient the presence of accompanying diseases which would lower resistance his nutrition his social environment his habits as regards exercise etc and above all his mental equipment—

intelligence determination to recover and amenability to the requirements of long and arduous treatment

(*d*) The type of disease is important as the neural type shows greater and the cutaneous less resistance

(*e*) The lepromin test (see Appendix III) is of value as showing the degree of cellular reaction and therefore of resistance to *B lepræ*

(*f*) The erythrocyte sedimentation test (see Appendix II) is of value as almost all conditions which cause debility and lower the patient s resistance to leprosy tend at the same time to increase the sedimentation rate

The assessment of all these numerous factors requires skill time and patience and their estimation must not only precede treatment but must be repeated from time to time during the course of treatment

(3) *Causes of Lowered Resistance*

Among the many factors which lower the patient s resistance may be mentioned —

(*a*) Diseases acute and chronic These may be so slight as not to be recognized in themselves but sufficient to tip the balance in favour of leprous infection

(*b*) Physiological changes such as those accompanying puberty pregnancy etc

(*c*) Mental complexes and disorders which cause a strain on the physical structure

(*d*) Nutritional deficiencies due to faulty diet digestion absorption or metabolism

(*e*) Climate social economic handicaps whatever they may be

This list could be enlarged indefinitely but the above should be sufficient to indicate the main lines along which search should be made in investigating the causes of lowered resistance

Part Two

TREATMENT

CHAPTER XV

TREATMENT—GENERAL

(1) *Principles of Treatment*

While general principles may be laid down it should be made clear that success must depend upon careful attention to each case The best results are obtained by (*a*) the raising the patient s general health and resistance to the highest possible level and (*b*) giving the maximum amount of the most effective special treatment consistent with maintaining the general health By *General Treatment* is meant all measures used to improve the general health to eliminate complicating diseases and when lepra reaction is present to desensitize the patient *Special treatment* consists in the use of certain drugs with a view to destroying the infection

It is not intended to draw too clear a line of distinction between general and special treatment or to suggest that the former should cease when the latter begins Special methods when carefully regulated may often improve the general health by clearing up lesions and general treatment will often cause a marked improvement in the leprous condition However in general the distinction holds and both forms should be employed in the great majority of cases It is important to remember that practically all effective forms of special treatment produce a negative phase or temporary depression of the patient s resistance to leprosy

(2) *General Treatment*

Complicating conditions found in the original examination and others arising later are to be corrected as far as possible Malaria chronic dysentery pyorrhoea helmin

thic and streptococcal infections and venereal diseases are among the most common complicating diseases though these vary in different countries In debilitated patients especially those that are sensitized and suffer recurring attacks of lepra reaction it may be months or years before special treatment can be tolerated these cases sorely tax the ingenuity of the physician

As in tuberculosis a temperate climate with not too great humidity is the most favourable Due to anidrosis

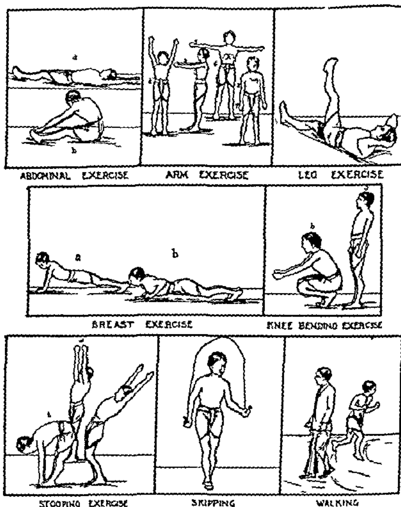


FIG 58

Chart of useful exercises to be used in leprosy

and other changes in the skin the heat regulating function is often interfered with and excessive heat or cold imposes an extra strain thus in hot countries the coming of a cooler season or removal of the patient to a cooler climate is often followed by improved health

The question of food is important and an appropriate well balanced diet is essential Cod liver oil combined if possible with ultra violet ray treatment is useful in some cases In others 0 5 to 1 0 grain of dried thyroid extract daily at bed time has changed the whole aspect of the case but care must be taken in giving this drug The stomach content is sometimes deficient in hydrochloric acid and such patients improve markedly with 0 5 ounce per diem of dilute acid Many slight deficiencies which apart from leprous infection would not be of importance and would not draw the attention of the physician are sufficient to tip the scale between improvement and increase of the disease

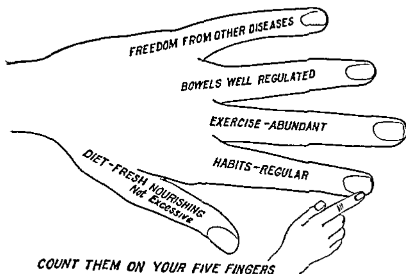


FIG 59

An important part of general treatment consists in regulating the patient s time-table He should have suitable mental and physical occupation and thus avoid brooding and depression

Physical training is of very great importance It should be progressive and not taken in excess Some simple chart of physical exercises may be used (fig 58) Walking games and other forms of open air exercise are of value The patient should as far as possible consider himself in training as regards exercise diet and regular habits (fig 59) The firmer the muscles and the better the physique the more rapid will be the progress towards recovery and the better will the patient tolerate the special treatment

The Sedimentation Test (see Appendix II) is of great value in determining the need for and in regulating general treatment

Above all the mental condition of the patient must be considered This question will be discussed in detail in *Control of the Patient* Chapter XVIII

We have already mentioned (p 29) that in a large proportion of early cases leprosy is a self healing disease which disappears spontaneously or as the result of general treatment and the restoration of the patient s health

At the other end of the picture even the C or C_3 case may heal up spontaneously but on the path to recovery he usually passes through the neural type of the disease and though the infection dies out he is left a deformed and disabled cripple

A positive Wassermann or Kahn test occurring in an early or resistant type of leprosy may be taken to indicate treponemiasis (syphilis or yaws) but in more advanced cases of the cutaneous type leprosy alone apparently gives not infrequently positive results with these two tests In weak patients of the cutaneous type of leprosy vigorous treatment with arsenicals and other drugs may bring on harmful lepra reaction

CHAPTER XVI

TREATMENT—SPECIAL

(1) *Introductory*

In choosing the form of special treatment the best remedies and methods known at the time should be adopted As a rule experimentation should be left to physicians with wide experience and suitable facilities The literature of leprosy is full of accounts of experiments on two or three cases made by doctors with little or no previous experience and incapable of truly evaluating the results Methods of treatment have progressively improved especially during the last ten or fifteen years

In making recommendations we shall confine our attention to drugs and methods which after much trial and experience are at present generally approved The writer is naturally influenced by his own experience but he is on the whole in line with the majority of other workers

We would emphasize once more that almost all effective forms of special treatment have a depressing effect they produce a negative phase which varies in length and degree directly with the size of the dose and the frequency of injections and they must therefore be used with due regard to the tolerance of the patient

In debilitated or sensitized patients special treatment should be withheld or given with great care and concentration placed upon improving the general health The first dose must be tentative the second should be given only when the negative phase of the first has passed off gradually the dose is raised till there are indications that the limit of tolerance has for the time being been reached Later as the general health continues to improve and infection is eliminated larger doses may be tolerated

(2) *Chaulmoogra Oil*

Among the various remedies used in the treatment of leprosy chaulmoogra or hydnocarpus oil obtained from the seeds of Taraktogenos kurzii (N India) Hydnocarpus wightiana (S India) Hydnocarpus anthelmintica (Siam) and Carpotroches braziliensis (S America) still holds the first place We shall therefore describe this form of treatment and later refer briefly to other drugs (see figs 60 61 62)



FIG 60
Hydnocarpus wightiana tre

Chaulmoogra oil has been used in India for hundreds of years in the treatment of leprosy and other skin diseases It was originally given by inunction and oral administration but the crude oil prepared as it was from stale seeds and oxidized through improper storage was found painful and otherwise unsuitable for injection Pain was lessened by dilution with inert substances and by mixture with anodynes such as ichthyol etc

Sodium salts of the fatty acids may be given in watery solution both intramuscularly and intravenously but the former method is painful and the latter causes endophlebitis and blocking of the veins These salts in the form of

Alepol are still used and have the advantage of being of small bulk when sent to countries where the oil is not produced



FIG 61
B cl f H ght ith fruit

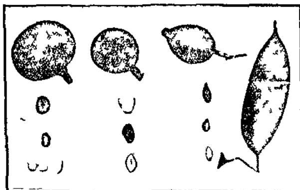


FIG 62
Fru t s eds d ti ated ds ditto in ti n f (*l m l ft to ght*) Gynoc dia odo at T ktog nu kur nd Hy In rpu wight a flow and l af of the la t

Esters are prepared from the whole oil and from various fractions the latter while much more difficult and costly to produce have been found to be of no greater value than the esters from the whole oil (see Appendix I)

Later it was found that oil extracted by cold compression from fresh ripe seeds was no more and often less painful than the esters though it is more viscid and is absorbed more slowly Probably both oil and esters are equally effective

In the Philippines the esters are iodised with a view to reducing the irritating qualities but we have not found this necessary with the esters prepared in India by the methods described in Appendix I

The addition of 4 per cent creosote to both the oil and the esters renders them less viscid antiseptic and possibly a little more effective Both forms should be sterilized by heating to a temperature of 120°C for half an hour either in an autoclave or in an oil bath If an autoclave is used care should be taken that moisture does not enter the bottles as this often makes the drug painful on injection

Syringes and needles should be sterilized in oil heated to a temperature of 125 to 135 C Such a temperature insures instantaneous sterilization (see fig 63)

Though various forms of injection (intramuscular subcutaneous intravenous and intradermal) have now taken precedence of the older methods of inunction and oral administration the latter are still often used as supplementary methods

(3) *Intradermal Infiltration*

This method the plancha method of the Philippine workers including the infiltration of subcutaneous leproma undoubtedly gives better results than intramuscular and subcutaneous injections it is not difficult for any leprosy worker to satisfy himself on this point by treating some of a patient s lesions by intradermal infiltration and leaving others to serve as a control In patients in whom the skin areas involved are too small to permit giving the desired

doses bv the intradermal route alone supplementary intramuscular or subcutaneous injections may be given

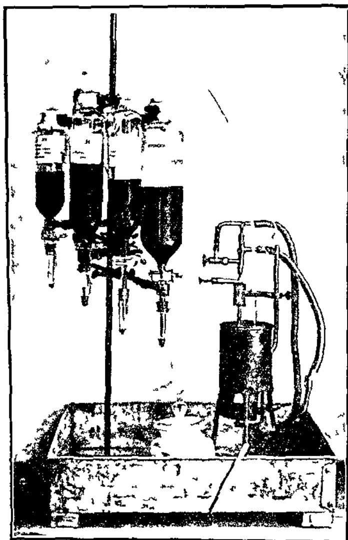


FIG 63

T th l ft Separat for fill ng syringe with o l or ester
To th ht App tus f sterili ing n edles n o l at a temp ture of 130 degr s C

Objections have been raised that as leprosy is a general disease infiltration of skin lesions will not affect the disease as a whole especially in the internal organs but *there is reason to believe that the benefits of these injections* are not confined to the lesions infiltrated

For intradermal infiltration either the pure oil or the esters may be used with the addition of 4 per cent creosote The oil is more slowly absorbed but in patients with extensive lesions it may take several months before the whole affected area of the skin can be infiltrated and prolonged retention of the drug in the lesion may increase the local effect

The viscosity of the oil may also be lessened by heating it on a water bath to 55°C The greater difficulty of injecting is still further overcome by using a short guarded needle The oil is necessarily much cheaper than the esters *and it is easier to ensure uniform quality* The H wightiana oil obtainable in India with 4 per cent creosote added causes on the whole no more irritation than the creosoted esters

Technique of Intradermal Injection A small syringe is used and except for reaching the deeper lesions a short guarded needle (see fig 64) is con

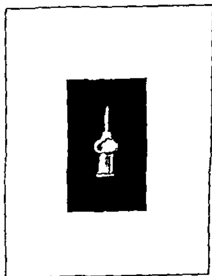


Fig 64

Convenient guarded needle for intradermal injection

venient as it control the depth of puncture The quantity of drug to be injected is drawn up or poured into the syringe if oil is used its temperature must be at least 55 C The area to be injected is marked off with a grease pencil and sterilized with spirit or iodine Infiltration is made through multiple punctures 6 to 10 mm apart From 0 05 to 0 1 c c is injected at each puncture so that in order to give the maximum dose of 6 c c some 60 to 120 punctures are required Each injection raises a wheal or if the skin is thick causes the markings to stand out in increased relief (see figs 65 and 66)



FIG 6

Giving intrade n l inj ction N t exaggerat d skin markings wh inj t n ha b n given



FIG 66

Intrad rm l inj ti n Not wheal ra ed

If a large area has to be covered the punctures may be spaced more widely The needle should be sloped to an acute angle with the skin surface and should not enter to a depth greater than 2 or 3 mm except in the case of deeper lesions

In patients with marked fibrous nodules it is sometimes well to begin treatment by infiltrating them first the more diffuse lesions being treated later With an ordinary hypodermic needle 2 to 4 drops of the drug are slowly injected into the middle of the nodule which will first swell and later shrink with or without liquefaction and discharge

Dose The dose will vary according to the tolerance of the patient from 0 5 to 5 c c given once or twice a week In active patients in good condition the larger doses are tolerated but as has been said it is well to begin with the small doses and gradually work up Pain and ulceration may result if too much is injected at one point or if the injection is too superficial or if the drug is unduly irritating

Almost all skin areas showing either visible lesions or deep analgesia due to local invasion by *B lepræ* are suitable for treatment by this method but secondary neural lesions should be avoided Since lesions may be present without outward signs one should not necessarily consider the absence of a visible lesion as a contra indication for infiltration if analgesia is present

When lesions are widespread it is often well to begin with the back of the trunk as the skin is less sensitive and the process of injection cannot be seen by the patient the face and other more sensitive regions may be treated when the patient has become accustomed to the injections A record of treatment may be charted (fig 67) to ensure systematic covering of all the areas affected (see Appendix VI and VII)

As a rule at least one month should elapse before any lesion is re infiltrated so as to give time for the induration caused by the previous injection completely to disappear otherwise considerable pain and even ulceration may occur Spots of hyperpigmentation remain at the old sites of puncture and the new punctures should be made between these Analgesia is generally less in areas already infiltrated so that more pain is felt on each successive occasion However patients as a rule are willing to suffer pain when they see definite improvement With patients showing high general resistance and few lesions

it may be sufficient to infiltrate all the lesions at one or two sittings and not repeat treatment for a month

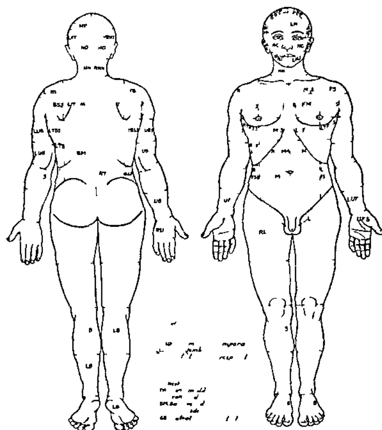


Fig 67

Division of body surface into 100 areas with the purpose of noting lesions or dividing treatment

(4) *Intramuscular and Subcutaneous Methods*

In some cases intradermal injections may be found impracticable and in these the intramuscular and subcutaneous methods may be used For intramuscular injection the gluteal region is the site of choice Injections are given deep into the muscles carefully avoiding the bone and the sciatic nerve The patient should preferably be seated on a stool The dose should be divided into

several portions the needle being partly withdrawn and re-inserted at a different angle after each portion is injected (see fig 68) Similar injections may be given sub

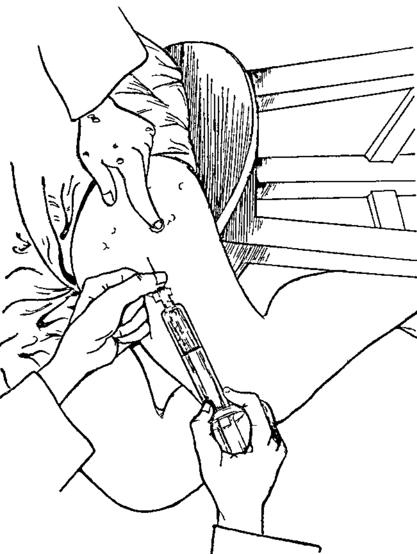


Fig 68

M thod of giving multiple subcuta eous or intr m u cul r injections through one sk n puncture

cutaneously in divided doses not more than one cubic centimetre being injected at any one point Deep

massage should be applied after injection in order to facili tate absorption

The usual dosage is 0 5 rising to 6 c c and given once or twice a week according to tolerance

(5) *Supplementary Treatment*

Absorption of leproma can be promoted by various applications to the skin such as rubbing with chaulmoogra or other kinds of oil hot baths and the application of caustics CO_2 snow is useful for application to nodules For macules or diffuse lesions painting with a solution of trichloracetic acid is at least as effective and much easier to



Fig 69

P inting v th trichloracet c cid

apply and its effects easier to control A 1-in-3 solution in distilled water is painted on one or more of the macules or when the disease is diffuse on an area of 2 to 3 square inches according to the tolerance of the patient (see fig 69) As this dries a moderate degree of whiteness should appear otherwise the painting is repeated The whitened appearance makes it easy to regulate the amount of painting and avoid excessive application which might result in ulceration A different area may be painted at each sitting but no part should be repainted for a month or till the signs of cutaneous irritation caused by the previous application have entirely disappeared Even stronger solutions may with advantage be applied to nodules

(6) *Other Drugs*

We have given above the lines of treatment which after many years of careful experimentation we have found most useful and which we therefore recommend We strongly urge workers with limited experience or limited opportunities for carrying out carefully controlled experiments to accept our recommendations as at least a basis of treatment No one who has not become through long experience familiar with the course of leprosy in its many stages phases and phenomena is qualified to evaluate the results obtained with new drugs still in the experimental stage

The heavy metals—arsenic antimony mercury gold copper—and also the aniline dyes are in small doses capable of desensitizing patients suffering from a chronic *mild form of lepra reaction which is very frequently present* Probably the improvement which so many observers claim from their use is in large measure due to this fact

Excessive treatment with chaulmoogra and other drugs by depressing the system and thus weakening the power of the tissues to react to *B lepræ* causes flattening out of skin lesions apparent clinical improvement and temporary amelioration of neural symptoms But the infection is not lessened in this way and in the long run the

patient's condition is found to be worse Undoubtedly many remedies have received a false reputation on this account We would again warn our readers that no real improvement can be made through any yet known drug apart from raising and maintaining the general health of the patient

CHAPTER XVII

TREATMENT OF LEPRA REACTION—(LEPRA FEVER)

We have shown in Chapter IX that this condition is associated with debility It is important therefore to improve the general health of the patient

Lepra reaction in some cases yields readily to treatment but in others one remedy after another has to be tried Any underlying cause such as concurrent disease should be sought and dealt with Constipation if present should be corrected If fever and other marked constitutional signs are present rest in bed and light diet are indicated *Alkalis* are often of value given in the form of sodium bicarbonate 120 grains in water orally three or four times a day

The heavy metals in small doses are often useful in desensitizing patients Perhaps the most useful of these is *potassium antimony tartrate* This should be given in 0 02 to 0 04 gram doses intravenously dissolved in 2 c c of distilled water one every second day but this drug should be discontinued if the reaction is not controlled within two or three weeks Larger doses or longer administration may produce the opposite effect and make the condition worse

Various aniline dyes given in small doses have been found valuable A one per cent solution of mercurochrome in distilled water given intravenously will sometimes control lepra reaction when other drugs fail Begin with 3 c c and inject every five days raising the dose to 5 7 10 c c if tolerated well The maximum dose of 10 c c should not be repeated more than three times Other aniline dyes such as *trypan blue fluorescein* etc may be given in similar doses intravenously Aniline dyes (methylene blue trypan blue fluorescein etc) have also been

found useful by oral administration 2 grain tablets being given once or twice a day up to two weeks

Calcium chloride 2 per cent given intravenously in doses of 20 to 30 c c daily for a week has been found useful by some workers A change of climate may be necessary to stop recurring attacks of lepra reaction

The value of these various forms of treatment varies with different patients Every effort should be made to improve the general condition of the patient and rest combined when the temperature falls with carefully regulated exercise is one of the most important means to this end

Exacerbation of neural symptoms during lepra reaction may often be relieved by subcutaneous injections of 0 25 to 0 5 c c of 1 in 1 000 adrenaline diluted with saline along the course of the nerve Ephedrine sulphate 0 04 gram ($\frac{3}{4}$ grain) may be given orally or it may be infiltrated round the painful nerves dissolved in 10 c c of 0 5 per cent sodium bicarbonate in distilled water Operative treatment to relieve nerve pressure may be indicated This is described under regional treatment in Chapter XIX

CHAPTER XVIII

Treatment—Duration of Course and Control of Patient

(1) *Length of Treatment*

The earlier treatment is begun the more successful is it likely to be and the shorter will be its necessary duration

Generally speaking treatment should continue until or even for some time after the disease is quiescent i e after the case ceases to be an active one In the Leonard Wood Memorial Conference Report Ref *active cases* are defined as follows — those in which there are clinical or microscopic evidences of progressive or of recessive changes in lesions with or without accompanying systemic dis turbances These evidences include the following positive bacteriological findings in skin or mucous membrane determined by the usual methods the presence of raised or erythematous lesions increase or diminution of lesions in size or number tenderness of nerves with or without thickening

The main factor in the recovery of the patient is his general health special treatment is supplementary There fore the less satisfactory the health of the patient and the slower the progress of his recovery the more prolonged and carefully managed his special treatment must be and the longer the period of after care

Arrested cases are those which have remained quiescent for a period of at least two years (Leonard Wood Memorial Conference Report)

Even after arrest however patients should remain under observation for a prolonged period of from one to seven years the longer period being for those who have been

severe cutaneous cases and for those whose general health is unsatisfactory or who live under unfavourable social economic and other circumstances

Iodide Test —When cutaneous or mixed leprosy has reached a stage in which repeated bacteriological examinations of the skin and nasal mucosa give negative results the iodide test is of considerable value *It should only be used however in cases in which the general health is of a high standard and the sedimentation test gives uniformly satisfactory findings* We do not advise its use in early or slight neural cases or in the juvenile type The method of carrying out the test is described in Appendix IV

Absence of reaction to large doses of iodide does not imply complete elimination of infection though it does as a rule indicate that large foci of bacilli in vascular areas are no longer present Occasionally however advanced cutaneous cases are found who do not react even to large doses of iodide

(2) *Control of the Patient*

One of the greatest difficulties in treating leprosy is the length of time required Modern improvements have led to more rapid progress and patients tend to present themselves at an earlier stage but on an average treatment of at least 3 to 5 years is required in well established cases The emphasis laid on general treatment makes it clear that without the intelligent and willing co operation of the patient good results are impossible Obviously compulsory treatment is not likely to be successful and in all cases careful patient and repeated instruction is necessary

In clinics and hospitals old patients who have made definite progress towards recovery give encouragement to newcomers The patient who is treated privately may lack this form of help and the physician must make up for it by encouraging him in other ways Arrive at a careful prognosis and make it clear to the patient at the same time explaining to him that his chance of recovery depends largely on his own efforts and intelligent co operation

In determining whether a patient should be treated as an in patient or an out patient the most important matter to be taken into consideration is the danger of his spreading infection but as far as treatment is concerned the patient with high resistance and suitable home conditions who is making favourable progress towards recovery may profitably be dealt with at an out door clinic On the other hand for the patient with low resistance or with complicating conditions it is exceedingly desirable that at least the initial treatment be carried out under the close supervision possible only in a hospital Another consideration is the social economic and hygienic condition of the patient s home If he is likely to be ostracised and mentally depressed if the food is insufficient or unsuitable or if the accommodation surroundings or climate are unfavourable the chances of the patient s recovery as an out patient are considerably diminished and if possible he should be treated as an in patient

Happiness and good spirits have a most beneficial effect in leprosy The mind should always be kept fully occupied and the patient kept from brooding on his own condition The *will to get better* is an important factor without which even the best treatment may fail

A dry temperate *climate* is best Extremes of heat or cold especially when accompanied by a high degree of humidity are unfavourable

The patient should if possible take his temperature and record it on a chart four times a day It is possible for the doctor by reference to this chart to regulate the treatment and to give other special advice to the patient

We give in Appendix V a simple form in which the patient may jot down his temperature and in Appendix VI another form in which the record of the case and the treatment and progress may be recorded

CHAPTER XIX

TREATMENT—REGIONAL

(1) *Perforating Ulcers*

The treatment of a perforating ulcers depends on the depth of the lesion and on the state of the nerve supply Secondary infection and induration of the ulcer often prevent healing If the supplying nerve has been destroyed healing is very difficult

Complete rest in bed and soaking the parts in mild antiseptics (water bath or repeated poultices) will cause at least temporary healing if dead bone is absent but the new tissue is apt to break down when the patient begins to walk again Patients may give rest to ulcers and yet obtain exercise by walking about on crutches or by using a wooden bucket leg by means of which the weight of the limb is thrown on the knee Carefully padded shoes are also of use

If the lesion is deep and involves bones or joints the dead tissue must be removed Contrary to the usual rules of surgery one must guard against being too conservative in excising bone If possible careful X-Ray photographs should first be taken If the head of a metatarsal is diseased and the rest of it shows decalcification it is well to remove the whole bone If in doubt remove too much rather than too little bone The patient can generally walk quite well on a shortened or narrowed foot provided there is sound healing The toxins absorbed from a chronic ulcer and the lack of exercise which it entails may prevent or delay the patient s recovery

Peri arterial sympathectomy has been recommended by some writers but its usefulness is not confirmed by others

Good effects have been reported from infiltrating chaulmoogra oil or esters into the tissues round about the ulcer and subcutaneous injections round over the supplying nerve

(2) *Thickened Nerves*

Reference has been made in Chapter XVII to the use of adrenalin ephedrine and sodium bicarbonate in the treatment of nerve troubles Diathermy if skilfully carried out is of considerable value in relieving nerve pain in subacute and chronic inflammatory conditions of the nerve

The ulnar nerve as it passes behind the elbow is often bound down to the bone and acute swelling of the nerve during lepra reaction may lead to strangulation severe pain and sensory and motor paralysis Incision of the constricting fibrous tissue gives relief of pain and if the



FIG 70

Atrophy of muscles and anæsthesia due to affection of peroneal nerve of right side The ink marks indicate immediate restoration of sensation of half the area after dividing fibrous tissue constricting the peroneal nerve as it passed round the neck of the fibula

operation is performed in time a considerable restoration of function (figs 70 and 71)

In acute lepra reaction the ulnar nerve may be constricted by its own sheath in which case linear incision of the sheath for 3 or 4 inches of its length above the elbow will relieve pressure or the sheath may be removed for the

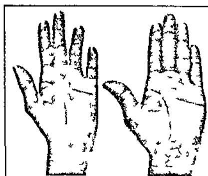


Fig. 71
Straightening and adduction of little finger after raising the epineurium of the ulnar nerve above the elbow

space of a few inches The peroneal nerve as it passes round the fibula may require similar operative measures

Single or multiple abscesses occur in the ulnar and other nerves They may be central causing swelling of the whole nerve or may herniate through the sheath Such abscesses should be incised and the contents scraped out drainage is seldom necessary (fig 19) Nerve stretching is not satisfactory

Resection of small thickened cutaneous branches may sometimes result in partial restoration of sensation to the skin area involved Resection of main nerves or larger branches is a useless and harmful procedure

(3) *The Eye*

Eye lesions in leprosy are due to either (*a*) leprotic invasion or (*b*) anæsthesia of the cornea and paresis of the eyelids

The former seldom occur unless there is involvement of the surrounding skin Since there may be considerable

affection of the eye without inconvenience or obvious clinical signs it is well to test with atropine all cases with lesions of the face or nose If there is any sign of fixation or irregular dilation of the pupil atropine should be given occasionally to prevent further fixation In giving special treatment to patients with eye lesions particular care should be taken to avoid reactions which are often disastrous to the eye If the pupil does not dilate with atropine drops subconjunctival injections of adrenalin and atropine may be given An ointment containing atropine sulphate gr $\frac{1}{2}$, dionine gr $\frac{1}{2}$ ung hydrarg grs 30 and vaseline *ad* grs 60, may be applied inside the lids two or three times a day for a few days In patients intolerant of atropine hyoscyamine or scopolamine should be used

Krysolgan and other gold preparations have been found useful in *lepra reaction* affecting the eye In our experience the most useful remedy for this complication is subconjunctival infiltration of a 1 in 1000 solution of *trypan blue* in distilled water Sufficient should be injected to balloon up the conjunctiva This may be repeated if necessary when the blue colour has disappeared At the same time the general treatment already mentioned for lepra reaction should be carefully carried out Iridectomy has been tried by some workers but the end results of such operations are seldom satisfactory

In the second type of eye lesion there is anæsthesia of the cornea paralysis of the lower lid and ectropion Consequently the protective mechanism of the eye ball is interfered with The cornea is apt to become dry and may ulcerate Liquid paraffin should be dropped between the lids frequently during the day and a pledget of cotton wool soaked in it should be tied over the eye at night Massage of the face around the orbit and intradermal infiltration of chaulmoogra esters in the periorbital region will often restore the function of the eyelids to a certain extent in early cases In the more advanced cases marginal tarsorraphy should be performed (fig 72) the eyelids

being closed sufficiently to protect the cornea without obstructing the pupil

(4) *The Nose*

In the majority of advanced cases of cutaneous leprosy the nose is affected particularly the septum The cartilagenous portion is frequently perforated and contraction may lead to depression of the nose Since many bacilli are

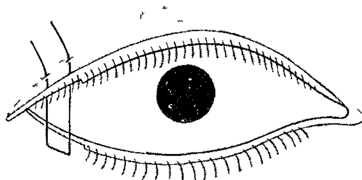


FIG 72
Plastic operation to bring eyelids together in lagophthalmia

mixed with the nasal discharge it is probable that this is one of the most serious causes of the spread of infection

Various forms of treatment have been recommended to remedy this condition In our experience the most effective is to paint the mucosa with 10 per cent trichloracetic acid after thoroughly anæsthetizing the mucosa with 5 per cent cocaine A speculum should be used and the caustic applied up to at least 1½ inches from the orifice this may be repeated once every two weeks for 5 or 6 weeks In arrested cases it is often possible to improve the appearance of the deformed nose by operation

In advanced cases considerable distress is often caused to the patient by the formation of crusts and obstruction of

the nasal passages Plugs of cotton wool soaked in glycerine or olive oil should be inserted in the nares and left there for half an hour so as to soften the crusts Thereafter the nares are irrigated with normal saline till the crusts are removed The interior is then treated with a chloretone spray or painted with hydnocarpus esters containing iodine or creosote This may be repeated two or three times daily until the crusts cease to form after which treatment with trichloracetic acid may be carried out

(5) *Mouth and Pharynx and Lungs*

The mouth no less than the nose may be seriously affected and become a source of the spread of the disease through droplet infection There should be frequent inspection of the teeth gums soft and hard palate pharynx and glottis Pyorrhœa and dental caries should be carefully treated Ulcers should be painted with trichloracetic acid or other caustics Obstruction of the glottis occasionally occurs and may require tracheotomy (fig 24)

In advanced cases of cutaneous leprosy large quantities of purulent sputum containing abundant acid fast bacilli may be coughed up the pus originating possibly in the lungs but more likely in ulcerating nodules of the pharynx It is important in these cases to exclude complicating tuberculosis If this exists rest and suspension of special treatment are required otherwise the patient should be encouraged to take regulated exercise and special treatment should be continued if the general health permits

(6) *The Ear*

The lobule of the ear is often enlarged and nodular and forms one of the most conspicuous stigmata of leprosy The appearance of a patient with this condition can be greatly improved by trimming the ear and removing the superfluous tissue (see fig 73) A clamp* curved to the

* A suitable clamp designed for the purpose is prepared by Messrs Down Bros London

shape of the pinna is applied tightly after sterilizing with spirit or iodine The lepromatous skin outside the clamp is then removed with a sharp knife Pure carbolic acid is applied to the raw surface and this along with a light dressing of cotton wool is sufficient to arrest bleeding No anaesthetic is necessary as the leprous condition renders the operation more or less painless The material removed may be used for the preparation of leprolin



FIG 73
Method of trimming unsightly nodular ea

CHAPTER XX

PROGNOSIS

(1) *The Importance of Reliable Prognosis*

Leprosy is not a fatal disease Patients die from complications and neglect rather than from the disease itself It is probably because of this non fatality and because the patient is afraid that he may be doomed to long years of suffering perhaps more mental than physical that he so much fears leprosy He has heard of or perhaps seen lepers in their more repugnant forms The word leper or its equivalent in other languages is associated with the last degrees of degradation and abhorrence In India it is called the great disease

The public and even the medical profession are unaware that leprosy may be a very mild disease and that even without special treatment many cases recover completely

Because of all these facts a reliable prognosis is perhaps of even more importance than in most other diseases

Under prognosis there are two main questions or groups of questions to answer —

(*a*) In contacts with infectious cases who so far have shown no signs of the disease what is the likelihood of leprosy developing ?

(*b*) In those in whom leprosy has developed and definite signs are present what are the chances of recovery how long will it take what are the chances of relapse will recovery take place with or without deformities and disablement ?

We shall discuss these seriatim

(2) *Contacts Without Signs of Leprosy*

In these the most important prognostic point to be ascertained is the age when contact first took place If this was within the first few years of life and especially if there was prolonged and close contact with a highly infectious case then even though several years may have elapsed and no signs of the disease have been noticed it is possible that a generalized infection may have taken place which will show itself sooner or later In such cases the Lepromin Test (Appendix III) is of great value If this test which consists of injecting intradermally a standardized suspension of Hansen s bacilli gives strongly positive results it indicates active cellular reaction to and phagocytosis of *B lepræ* This means enhanced resistance to *B lepræ* and the prognosis is therefore favourable In such cases if there had been any considerable foci of lepra bacilli in the skin or peripheral nerves they would have induced cellular reaction and clinical signs and no slight bacillary foci are likely to survive long in such resistant cases as they would be destroyed by phagocytosis

In child contacts especially children of leprous parents if the reaction to lepromin is negative or weak the prognosis must be more guarded In such cases careful clinical examination with the aid of a suitable light may reveal macules which had escaped notice or careful and repeated bacteriological examination of the skin and nasal mucous membrane may show acid fast bacilli

In cases of the juvenile type of leprosy (see Chapter XII) the absence or obscurity of clinical signs is due to the state almost resembling symbiosis set up in the non resistant tissues of the body the tissue response which is responsible for the appearance of lesions being at a minimum If the general health of the child is poor then the possibility of general infection having taken place is considerably enhanced

In the case of healthy adults who have been in contact with infectious cases and yet show no sign of the disease the prognosis is as a rule much more favourable, especially if

the leprolin test shows strongly positive results If a considerable period has passed since contact took place then definite signs of the neural type of leprosy would probably have declared themselves supposing that active infection were still present in the body

In adults who are or who have been in a poor state of health the danger of the infection developing is much greater If there is a history of severe or prolonged disease or of other predisposing *conditions during the interval* since contact took place if the sedimentation index is high (see Appendix II) and if the reaction to Hansen leprolin is negative or weak as compared to the control (see Appendix III) then a very guarded prognosis is necessary clinical or bacteriological re examinations may reveal positive signs sooner or later

(3) *Patients with Leprous Lesions*

In making a prognosis important questions are —

> What is the type and the extent of the disease is it progressing retrogressing or stationary if progressing at what speed is the general health good is the special resistance to leprosy high or low ?

In assessing the resistance it is important to go carefully into the history especially with regard to predisposing causes (see Chapter XIV) also the general appearance of the patient bacteriological examination and the extent of the lesions may give a clear indication The type is important the prognosis being generally much more favourable in neural than in cutaneous cases The leprolin and sedimentation tests are of great value (see Append II and III)

In resistant cases the prognosis is excellent provided the patient remains in at least moderately good general health The lesions should gradually resolve under treatment and the danger of relapse once all signs of active disease have disappeared from the skin and the nerves is comparatively small

In non resistant cases the prognosis is much more doubtful If the general health is good or if under suitable treatment it becomes good and especially if the sedimentation of erythrocytes is slow then a favourable though guarded prognosis may be given The period of treatment necessary will however be much more prolonged In many cases of low resistance a definite prognosis should be delayed until there has been time to observe the progress made under general and special treatment The effective treatment of complicating diseases along with the carrying out of a strict regime of careful diet active and suitable exercises and regular habits is often found to bring about within a few months or it may be in one or two years improvement up to a point at which a favourable prognosis can be made When this period has been reached and the danger period passed steady progress towards recovery may be expected though several years may elapse before there is complete elimination of all active signs

The question of recovery with or without permanent lesions and deformity is an important one to the patient The earlier treatment is begun and the more carefully it is carried out the less danger is there of the development of trophic lesions of the hands feet and face Carefully planned physical exercise is very important in this connection Nerve reaction in the ulnar and peroneal nerves which so commonly results in claw hand and drop foot seldom occur in patients with firm well developed muscles In most cases a certain degree of anæsthesia and if the larger mixed nerves have been involved of trophic changes in the small muscles is likely to persist These should not be mistaken for signs of active disease

Part Three
PREVENTION

CHAPTER XXI

Prophylactic Measures

(1) *The Mode of Infection*

Under *Etiology* in Chapter II we have summarized the factors favourable to the spread of leprosy as the infectiousness of the infector the closeness and length of contact and the susceptibility of the infectee

We have defined *uninfectious cases* as those in whom careful and repeated examinations of smears from skin and mucous membranes fail to show bacilli All other cases must be considered potentially infective though the degree of infectiveness varies in wide degrees Bacilli escape in large numbers from the ulcerating nodules and from abrasions and sores of advanced cutaneous cases They also escape from the mucous membranes of the nose mouth and pharynx Droplet infection is a special danger If a microscopic slide is held a short distance from the nose or lips of an advanced cutaneous case while he is sneezing coughing or otherwise making violent exasperatory movements it will often be found on examination to show numerous acid fast bacilli In some cases scrapings taken from the non ulcerating surface of the skin show clumps of bacilli

We have no clear proof of how the bacillus enters the body but the probability is that the chief portals of entry are abrasions of the skin or mucous membranes Picking the nose so common a habit among children is a likely means of entry

Mild infections with Koch s bacillus will often produce resistance to tuberculosis while massive infection will lead to the development of this disease There is considerable evidence that the same holds good with regard to leprosy

and that the degree and frequency of infection is of importance in determining whether or not the disease will develop and also the type of disease

There is a general consensus of opinion that children are more susceptible than adults and especially that children infected during the first few years of life are particularly liable to develop leprosy in its more serious cutaneous types Healthy adults are likely to escape or to suffer from the milder neural type In adults however severe or prolonged debility frequently changes a mild or latent infection into a virulent and rapidly progressive form

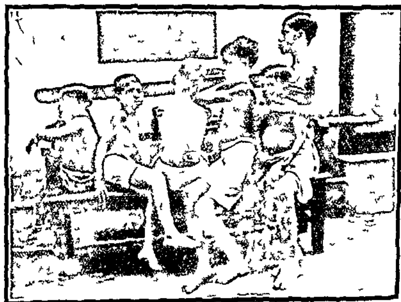


FIG 4

Six brothers all affected with leprosy The oldest brother is a C 3 case The other five are early cases as the result of contact

(2) *Precautions for Children*

Children should be separated from infectious parents at birth A child should never be allowed to enter the room occupied by an infectious patient or in any way to come into close contact either with such a patient or with any furniture clothes or other appliances which may in any way have been contaminated by such a patient Too

much emphasis cannot be laid on these rules for the whole leprosy problem centres round child infection The disease may not show itself till puberty or early adult life but it is chiefly those who have been infected in early life that later furnish infectious cases and hand on the disease to the next generation

(3) *Precautions for Adults*

Adults should as far as possible take similar pre cautions It is important that all adults who have to come in contact with infection should take every care to maintain a high standard of general health by means of abundant fresh air light and exercise and suitable diet They should carefully avoid droplet infection They should when they have to touch an infectious patient or anything likely to have been contaminated by him either put on rubber gloves or afterwards carefully wash their hands

(4) *Precautions to be taken by the infectious patient*

He should have a separate room for himself He should not touch furniture or other appliances used by others His clothes linen eating and other utensils should be kept strictly separate and not handled by others without due precautions He should avoid the danger of spreading infection by droplet infection either by keeping at a sufficient distance from others or by covering his mouth and nose when coughing sneezing etc It is important that the physician should carefully explain to the patient and to his attendants the possible methods of spreading infection so that precautions may be intelligently observed

The question of travelling in public vehicles is a difficult one Theoretically it entails danger to the public but in practice probably only a very small proportion of cases acquire leprosy from this source The chief danger is in the home or where intimate and repeated contact takes place

CHAPTER XXII

Public Health Measures

(1) *Introductory*

The methods of carrying out a campaign against leprosy must necessarily vary in different countries The education and social advancement of the people the distribution of the population the local government constitution the availability of doctors and other health workers and above all financial considerations have important bearings on the method most suitable in any country or community

Especially in countries where the population is sparse the communications defective and the people backward the leper settlement or village is undoubtedly the best method to begin with provided that it is efficiently run and that provision can be made for the separation and healthy upbringing of children

As leprosy is due to contact with infectious cases the obvious method of controlling the disease is to isolate all infectious cases

An attempt at compulsory segregation was made in the Philippines some 30 years ago all cases discovered being removed to the island colony of Culion But the fear of forcible removal led to concealment and it is now confessed that this method alone cannot stamp out the disease Accordingly the original scheme has been modified and improved The Philippines have a population of only twelve millions it has highly organized medical and health services and a large annual expenditure for public health work which has been aided by men and money from America If with these advantages compulsory segregation has so

far failed to cause a marked diminution in leprosy it is not likely to succeed in India Africa and other countries with their huge population and high incidence of leprosy

Though compulsion from outside the community is unavailing compulsion wisely applied within the community may be effective as we shall try to show later

We give below in some detail the methods which have recently been tried with some measure of success in some parts of India It is acknowledged that even in India these methods are not universally applicable But the underlying principles may be found useful when modified and adapted to local conditions

It is calculated that there are from a half to one million people suffering from leprosy in India If one fifth of these are infectious then there are one or two hundred thousand people who are spreading infection Could these not all be persuaded to isolate themselves voluntarily in institutions? At present in all the institutions throughout India in which leprous patients can be isolated there is room for only a few thousands To hold them all therefore we should have to increase the accommodation at least twenty times an impossibility from the financial point of view And even were there room for all how many could be persuaded to enter voluntarily? We conclude therefore that although excellent work is being done in the existing isolation institutions they are able to deal with only a small fraction of the preventive work that has to be done

(2) *Out Patient Treatment*

If we had a specific for leprosy then we might perhaps hope to control it by treatment though this has been found impossible in malaria even with a specific like quinine In leprosy though the treatment is of value we have not yet found a drug which has the specific effect that quinine has in malaria Therefore treatment centres alone even if there were sufficient of them and all the patients could be induced to attend could never control leprosy

The leprosy dispensary is suitable for certain types of patients living in towns or densely populated rural areas where they are within easy reach and can attend regularly But if the patient is weak the journey to and from the dispensary may counteract any benefit to be derived If his diet is unsuitable or if he lives in an unhealthy locality no special treatment is likely to benefit him

The *infectious case even if he benefits personally by* attendance at a dispensary may spread infection to many others during the course of prolonged treatment

(3) *The Problem of the Village*

Leprosy is a disease primarily of villages just as tuberculosis is a disease primarily of industrial centres It *belongs to a certain stage of sanitation and a certain* standard of living Once the disease has become endemic in a community it is not likely to be eradicated until that standard has been raised

Prevention is not difficult to carry out provided that the necessary knowledge is available and that there is general willingness on the part of the community to put a few simple rules into effective force

Both in India and in Africa the writer has repeatedly found that the people have the idea that crippled patients in whom the disease has almost or entirely died out are the most dangerous and most likely to spread infection Such cases are frequently isolated while the much more dangerous cutaneous cases are allowed to move freely in the community

Children are allowed to live with infectious cases because it is supposed that leprosy seldom attacks young children This misconception is *due to the fact that those* infected in early years often do not show definite signs of the disease till later

Thus there is often the will to prevent by isolation but the measures taken are ineffective because certain simple facts are not known

Again if the leper happens to be a person of comparative wealth or influence the community hesitates

to apply the restrictions which it would in the case of less important people

Yet a single highly infectious case mixing freely with his family and neighbours may spread the disease far and wide

(4) *The Propaganda Treatment Survey (P T S) Method*

This method has been tried in various parts of India A treatment centre is started Patients are followed up to their homes and gradually a leprosy survey is made of the villages from which these patients come The history of the spread of leprosy in each village is worked out as far as possible past and present cases being entered in maps and family trees and infectious cases being distinguished from non infectious (see Append VIII)

The nature of leprosy and the method of its spread is made clear to the villagers the past history and present condition of leprosy in their own village being explained to them and special stress being laid on the danger to their own children Persuasion is used to induce infectious lepers to isolate themselves and the community is advised to bring public opinion to bear on unwilling cases

(5) *Methods of Village Isolation*

Examples are known in India Burmah West Africa and other places where the lepers of a tribe or of a certain area have on their own initiative segregated themselves voluntarily in leper villages Communal segregation is better than individual isolation for the leper like every other human being has his social instincts and effective separation from the non leprous community is more likely to be complete if these instincts are satisfied

Provided that the majority of the individuals in a leper village are able bodied and that sufficient good arable land is available it should be possible for a leper village either to be entirely self supporting or at least to maintain itself with slight outside help Provision should however be made for treatment and rents and taxes might well be

cancelled or be paid either by relatives or by the community from which each leper comes

A leper village might be divided into two parts the one half being reserved for infectious and the other for non-infectious cases No young children should be allowed to enter the infectious division

In such leper villages the chief difficulty is the isolation of the young children of infectious mothers Either foster mothers must be found or they must be fed artificially These children must be carefully nursed up to the age when they can take ordinary food after which they can be handed over to non leprous relatives the provision for this is perhaps the most difficult but also the most necessary requirement in an anti leprosy campaign Training of young women in such child welfare work might well be practised in well staffed leper settlements

The leper village such as we have described is most practicable among primitive people who still maintain the clan or feudal system or where there already exists a

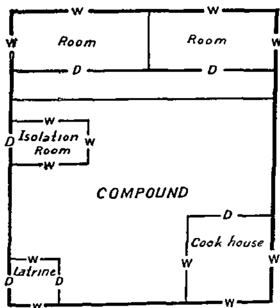


FIG 75

Method of home isolation The patient has no direct access to the compound but can receive food and communicate through the windows

well organized local authority either secular or religious whose word is respected and obeyed



FIG 76

Inf ctious lep r sol ted out de the village

In England the Church in the middle ages was largely responsible for the control of leprosy by a sufficiently effective form of segregation The funeral service pronounced by the priest over the leper who was considered to be dead to the community is an example of the methods used to this end

(6) *Individual Isolation*

In other places where local organization is less well developed it may be found impossible to obtain sufficient land or there may be other obstacles in the way of forming leper villages In these places an attempt may be made to bring about isolation of lepers either singly or in small groups Well-to do patients may be effectively isolated in their own houses or a small house may be erected in the family compound in such a way that the patient does not mix with his relations (fig 75) Indigent lepers may be isolated on the outskirts of the village land for cultivation being given or their wants being supplied by the community (fig 76)

CHAPTER XXIII

The Leprosy Clinic

(1) *The Nature of a Clinic*

In many parts of India the leprosy clinic a development of the Propaganda Treatment Survey method has been adopted as the means of controlling leprosy

By the word Clinic we mean a centre for various anti leprosy activities such as treatment propaganda survey social service and many other forms of work The urban clinic serves a town or a part of a town The rural clinic serves a group of villages and should therefore be situated in or near the most central and important village of the group

(2) *The Staff*

The minimum staff of a clinic apart from menials should consist of a doctor and a trained medical assistant of the status of a compounder or laboratory assistant Either the doctor or the medical assistant should be a whole time leprosy worker though it is better still if they can both devote their whole time to the work of the clinic In some places the doctor or the medical assistant may attend to two or even three clinics The doctor should be able to spend a large part of his time in visiting villages and organizing village committees A large part of the village visiting may be done by the assistant on non treatment days or in the afternoons when treatment is in the morning

How many cases can one doctor with one assistant treat in a day ? This is a difficult question to answer But roughly speaking when more than 100 cases have to be treated in a day a second assistant is necessary if the work is to be done efficiently

Training in leprosy work is all essential Leprosy is one of the most difficult diseases to understand and even for a well qualified doctor it is difficult to acquire all the necessary knowledge through reading literature alone There should therefore be at least one centre in each district at which doctors can familiarize themselves with anti leprosy work The assistants can attend a course at the same centre or they may be trained by the doctors at their own clinics during the course of work

If leprosy is to be controlled all classes of the community must take part in the campaign and for this end a representative clinic committee should be formed to allot and co-ordinate work The doctor in charge of the clinic should act as secretary of the committee and only those who are really interested and likely to be useful should be enrolled as members

(3) *The Building*

This should consist of a shelter for some 100 to 150 patients a room to be used as a consulting room laboratory and record room and a spacious verandah for injections This is the minimum useful additions are a store lavatory and a second room to be used exclusively as a laboratory and record room A good water supply and sanitary surroundings are essential

A very important addition but one which may involve some considerable initial expense unless existing buildings are available is ward accommodation for 2 to 6 patients in which may be housed those who need initial careful attention nursing and treatment and who are too ill to attend the clinic regularly After a few weeks special care they may recover sufficiently to attend for treatment as out patients Patients with lepra reaction perforating ulcers and other complicating diseases may be cared for in these wards The doctor carries out the treatment while the nursing and feeding is arranged for by the social service workers An intelligent patient may be hired to act as nurse and warder

(4) *Treatment*

What appeals to the patient is *treatment* this alone will attract him and patients must in the first place be attracted to the clinic Every case must be examined carefully and any accompanying diseases treated The diet habits personal and family history etc of each case must be enquired into and all these must be carefully entered on a case card (see Appendixes VI and VII) along with the particulars of the leprous condition Also the patient s name should be entered in a village card (see Appendix VIII) under the village to which he belongs All this requires a considerable amount of time and patience and if a large number of patients are attending the clinic it may be difficult or impossible for the doctor to undertake it all single handed Much of the case taking and tabulation may however be done by voluntary lay social workers

A large part of the treatment of the patient consists of teaching and the most effective way to carry this out is to take each patient s particular condition and circum stances and teach him what he has to do to get better It is important that he should understand that 75 per cent of the treatment has to be done by himself and that without his own efforts his chance of recovery is small The doctor can note on the card the kind of teaching necessary and the lay social worker can impress it on the patient

What the patient comes for and what he wants is *injections* these also are given but the patient must have impressed on him again and again that the most important part of the treatment is not the injections but following out the rules he has been taught

The question of how often the patient should attend the clinic is an important one It may be advisable for him to come twice a week to begin with until he has been treated for accompanying diseases and has got into the stride of his treatment Thereafter once a week should be sufficient especially if intradermal injections of hydnocarpus oil or esters are given These take longer to give than intra muscular injections but their action continues for a week

or more making more frequent injections unnecessary Many patients have to come a long distance and attendance is likely to be more regular if they have to come only once a week Also a larger number of patients can be treated as more time is thus made available In places where patients are poor and underfed cooked food is sometimes supplied at clinics Schoolboys may be enlisted in collecting from door to door or wealthy people may be induced to take their turn in supplying food

Thus the clinic supplies work to many people and at the same time educates the community (young and old educated and illiterate) in anti leprosy as well as general sanitary methods

(5) *Organisation in the Village*

But the clinic as described above will do but little to stamp out leprosy The stronghold of leprosy is in the village and unless this stronghold is attacked the guerilla warfare will last for ages

The *village card* (see Appendix VIII) has been referred to above Each village clinic is responsible for anti leprosy work in a group of villages and one or more village cards for each of these villages are filed in the clinic On the one side of the village card are (*a*) the name of the village clinic taluk and district (*b*) the population of the village a list of the various communities and the number of people in each community (*c*) notes on the village its situation physical features sanitation how leprosy came to the village and how it spread (*d*) a space for a sketch map of the village on which may be plotted out reference numbers of the cases of leprosy found according to their dwellings On the other side of the card there is a tabular form on which may be entered the names of the leprosy cases with the village serial number (as marked in the sketch map on the reverse) the case card number at the clinic age sex caste type and duration of the disease a space for remarks such as relationship to other cases etc There is a space for dates of visits to the village and the initials of the

visitor If more than 20 cases are found in a village then two or more cards may be necessary

The cards are filed (card index system) in the clinic under the charge of the doctor but much of the investiga tion may be done by assistants or by social workers trained by the doctor Suspected cases may be directed by health visitors to attend the clinic but a definite diagnosis of leprosy must always be confirmed by the doctor

In beginning a village campaign the village must first be visited either by the doctor or by one of his helpers Suspected cases are induced to attend the clinic for diag nosis Definite cases of leprosy are followed up to the village and contacts in the family and among the neighbours are examined (voluntarily) for signs of the disease It may take months and many visits to the village before all the cases are discovered but the facts that treatment is given and that the doctor and his helpers are kind and courteous and obviously out to help the patients prevent or overcome the desire to conceal Thus a leprosy survey of the village is gradually completed and the results are entered on the village cards

(6) *Propaganda*

The object of carefully gathering and recording this information is to form a basis for special propaganda General abstract propaganda—such as statements that leprosy is spread by contact children are most apt to be infected etc —is not likely to bear much fruit among ignorant uneducated villagers What is required is special propaganda giving in detail how the disease came to the village how it spread which are the infectious cases and so on These facts are recorded on the village card and if at every visit of the doctor or health visitor the same teaching is repeated *it is likely that the villager will at* last believe in its truth and be willing to act on it It is like the stone breaker who hammers repeatedly on the same spot of the large stone without apparent result but if he persists the stone at last falls in fragments Thus special propaganda based on carefully ascertained and

recorded local information and consistently and patiently repeated will in the end break through the ignorance and conservatism of the villager and win his co operation

In such work the educational authorities are able to help considerably The school teacher if trained in the nature of leprosy can teach his scholars and through them their parents and influence them to adopt the simple methods necessary for prevention

(7) *Prevention of Infection*

This should be the chief object in village propaganda It can best be achieved by preventing the contact of infectious patients with other people The various methods of isolation are dealt with in the last chapter We have made it clear that isolation cannot be enforced effectively from outside the community It can however be enforced by the pressure of public opinion Within the community two things are required (*a*) knowledge widely spread by means of repeated propaganda to all the villagers as to how leprosy is acquired and how it has spread in their village which are the infectious cases that have infected others and are still spreading the disease and what are the most effective means to prevent further infection (*b*) public opinion must be organized and brought into effective action If a village *panchayat* exists it is the natural body to act If there is no *panchayat*, an endeavour should be made to form one or to form a branch of the clinic committee which will command the respect of the village

(8) *The Clinic Committee*

This has very important functions to perform in the group of villages for which the clinic is responsible It has to look after the running of the clinic at headquarters and to help the doctor in all its details It has to organize branches in the form of village committees or *panchayats* and instruct and enthuse them in anti leprosy work It has to provide village inspectors who will tactfully and without any attempt at compulsion see that the village committees are carrying out their work effectively Honorary anti

leprosy workers must therefore be trained carefully either by the clinic doctor or preferably at a special training centre such as that mentioned above

Another most important function of the Clinic Committee is to see to the periodic inspection of all school children within its area Children showing signs of leprosy should be followed up to their homes and contacts examined to find out the source of infection

The organization of an urban leprosy clinic and its committee may be carried out along lines similar to the rural clinic the principles are the same though methods may be modified to suit circumstances

(9) *District Leprosy Board* *

We have described the formation and function of the leprosy clinic as a unit The number of such clinics in a district will naturally vary with the amount of leprosy present in the district The leprosy work of a district may with advantage be initiated co ordinated and supervised by a District Leprosy Board or Council which will co ordinate all the leprosy work within its area Its membership should contain representatives of clinics and of all the bodies in the district who are directly interested in the anti leprosy campaign

A district in India is an area with a population of one or two million people

CHAPTER XXIV

The Leprosarium

(1) *Types of Leprosaria*

These have varied according to the objects for which they were founded While leprosy was looked upon as a hopeless disease the *lazar house* and *leper camp* or *asylum* came into being the object being to isolate the leper from the community or to afford him a refuge where he might associate with his fellow victims

Later pity for the unfortunate leper led to the formation of *leper homes* where these outcasts might be tended and cared for

The realization that leprosy yields to treatment and that some cases especially in the earlier stages recover resulted in the founding of *leper hospitals*

In more recent years the importance of healthy exercise and occupation-therapy has been emphasized It is realized that the long periods of treatment necessary for recovery must be spent under normal physical mental and social circumstances Hence the *leper settlement* or *colony* Here treatment both general and special is carried on and a hospital is supplied for cases which require temporary hospitalization but the main stress is laid upon agricultural and industrial employment as such occupations afford the atmosphere and conditions most important for control of the disease and in favourable cases for recovery

We shall therefore describe the general principles on which leper settlements should be formed

(2) *Nature of Settlements*

A settlement should have accommodation for 500 to 1 000 patients Smaller units having reference to whole time staff and overhead charges are not economical

There seems to be general agreement that they are most effectively and economically run by mission doctors nurses etc or by those who have the missionary or altruistic outlook on life Funds should be supplied by Governments and Local Bodies and supplemented by charities These are required for founding the colony and for maintenance though in a well conducted colony the expenditure per head should diminish as self supporting agriculture and industries are established

(3) *The Staff*

Preferably there should be two doctors on the staff one of whom can organize preventive work throughout the area which the settlement provides for and relieve the other at headquarters during leave Failing this there should be a layworker of practical ability and education who can help the doctor in part of the work Two nursing sisters should be appointed who can organize the hospital work train nurses and Infant Welfare Workers supervise Welfare Centres and relieve each other while on furlough Failing two sisters there should be a second sister available from some other hospital for furlough relief and who can give part time to help in training etc

The subordinate staff may consist to a large extent of intelligent patients who have been trained to act as dispensers nurses medical assistants and laboratory workers but there should be two or three non lepers trained in laboratory work etc

(4) *Site of Settlement*

(*a*) Four or five hundred acres of good arable land with suitable soil preferably in elevated undulating country and not excessively hot

(*b*) Not on a main road but within one or two miles of a main road Communication with all parts of the area should be as easy as possible and yet the settlement should be far enough away from main towns and lines of communication to render easy isolation in a well disciplined settlement

(c) A good water supply available both for domestic use and for cultivation is very essential

(d) The site should be healthy, or capable of being rendered healthy with special reference to malaria and other diseases

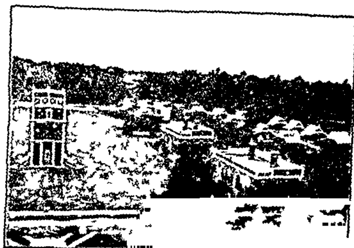


Fig 77

Leprosarium

(5) *Types of Buildings* (see fig 77)

(a) There should be good permanent buildings for staff hospital dispensary store laboratory and healthy children s home which will not require frequent expenditure or repair

(b) For the patients there should be cheap huts of a nature similar to those of the best type in the locality These can be erected by the patients themselves at a very low expenditure Schools and other public buildings can be erected of similar materials

(6) *Types of Patients to be admitted to Settlements*

(a) There should especially at first be predominently hopeful cases who come voluntarily with the object of recovery If the majority of cases are of the disfigured and disabled type, who have no hope of or interest in recovery then the morale of the settlement will be rendered

hopeless and development on the right lines be found utterly impossible

(*b*) Early cases of the abortive type those not likely to develop the disease in an infective form should not be retained in the settlement to the exclusion of highly infectious cases though to begin with the treatment and recovery of the more mild forms of leprosy will render the settlement popular

(*c*) The main type admitted should be the highly infectious C2 and C3 cases who though harbouring a high degree of infection are capable of being rendered physically strong and healthy and are able to undertake a fair amount of work

(*d*) Leprous patients suffering from other and remedi able diseases from which they may be treated in the hospital and settlement

(*e*) Mothers of the infectious type may be admitted before child birth with a view to isolation of new born children

(*f*) When leper villages as described in Chapter XXII are organized the types of patients to be admitted to the Settlement should be reconsidered Patients might be admitted temporarily to the latter and undergo thorough examination and treatment for accompanying diseases After a period of training and instruction in personal hygiene etc many of them could be drafted to leper villages where they could continue under treatment thus making room for the admission of fresh patients to the settlement

(*g*) A certain number of intelligent young patients in the milder stages of leprosy should be admitted not only with the object of treatment but also that they may undergo special training in the recognition treatment and prevention of leprosy Those may later be of value in treatment centres in co operating with leprosy clinics in carrying out leprosy surveys in villages and in organizing leper villages and carrying out treatment and Child Welfare in these when formed

(7) *Work in the Settlement*

One of the most important factors in the treatment of leprosy is healthy physical exercise up to the capacity of the individual Without this no other form of treatment is likely to be of permanent value Such exercise may be obtained by communal work in the Settlement such as making and repairing of roads and houses bush clearing and all other activities dependent on communal life It can also be obtained by individual farming on land either given by the Settlement or rented by the patient himself from a neighbouring land owner

Self support should be aimed at as far as possible Allowances in money and kind are necessary in the majority of cases to begin with but patients who are physically strong should try to support themselves by their own efforts Progress towards self support will however depend on sufficiency of land for agriculture the establish ment of industries on a commercial basis and the finding of suitable markets for agricultural and industrial produce In proportion as these are lacking the patients must be subsidized to a certain extent Obviously very few articles produced in a Settlement are marketable outside most of such produce must be consumed within the Settlement

(8) *Settlement Schools and Training*

As the hope of recovery depends to a large extent on the intelligent co operation of the patient the educational work done in a leper settlement is of great importance Patients have to spend as a rule several years in the Settlement and it is important that children and adolescents and a certain proportion of young adults should attend school After learning the rudimentary subjects they can be taught to help in treatment and trained in other useful subjects especially rural hygiene Above all they can be trained with regard to the treatment and prevention of leprosy so that when the disease becomes arrested and they return home they may take an active part in the campaign against leprosy in their own villages and in leper villages

(9) *Voluntary Segregation*

Voluntary segregation has the great advantage over compulsory segregation that the goodwill and loyalty of the patient are secured He is receiving a benefit not conferring it and is therefore grateful and willing to co operate Without this co operation it is difficult to carry out treatment successfully If the doctor once begins running after the patient begging him to do things then he will have to continue to run faster and faster if he is to retain his goodwill

(10) *Leprosy as a Key Problem*

The efficiently organized leper settlement may act as a model in the area in which it is situated Patients returning after recovery to their own villages may spread the knowledge they have acquired regarding not only the control of leprosy but also general public health methods In this way anti leprosy measures may embody general sanitary reform and act as a key to the solution of other problems

APPENDIX I

PREPARATION OF ESTERS

For those who desire to use the esters there are two methods recommended for their preparation —

(1) *Cold Process* —425 grammes of crude cold hydnocarpus oil 550 c c of 96% ethyl alcohol and 32 c c of sulphuric acid (sp gr 1 845) are placed in a bottle with a tight fitting glass stopper and left until the process of esterification is complete (fig 78) The bottle should be

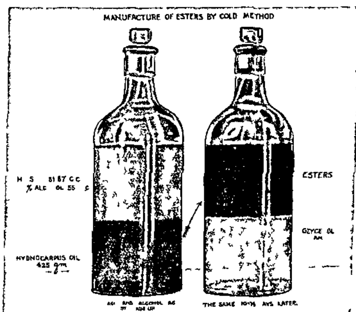


FIG 78
Cold method of making hydnocarpus esters

shaken once or twice a day to mix the upper and lower layers This hastens the process as does also the placing of the bottle in the sun or in some warm place Neither

the shaking nor the heat are however essential if time is not a consideration To begin with the oil forms a lower and the alcohol and acid an upper layer As esterification proceeds a point is reached at which the lower layer now chiefly composed of esters gains a lower specific gravity than the upper layer which now contains a large proportion of glycerol and the former therefore rises to the top To ensure the completion of the esterification it is well to allow the process to continue further for the same time which elapsed between the mixing of the ingredients and the rising of the lower layer Thus if the lower layer takes 14 days to rise the ingredients should be left in the bottle for 14 days longer If a sample from the upper layer dissolves completely in alcohol it is a sign that esterification is complete as alcohol completely dissolves esters but not oil The lower layer is then drawn off and the upper layer washed with an equal volume of water twice over till the washing water is free from acid as tested for by litmus paper and then with a 0 1% solution of sodium hydrate in water which forms a thick emulsion crystals of common salt are gradually added in small quantities and brought in contact with the emulsion by slowly rotating the vessel so as to break the emulsion On standing the esters will rise to the top When this has taken place the lower layer is removed and the upper layer consisting of esters after being washed once more with distilled water is filtered through thick filter paper The esters though now clear still contain a certain amount of fine emulsion which makes them dark in colour This may be removed by drying on a water bath for two or three hours while stirring constantly with a glass rod The esters are then filtered again and the process is complete

The esters may be washed in the same bottle in which they have been prepared by substituting for the glass stopper a cork perforated with two glass tubes the one two inches in length inserted flush with the inner end of the cork and fitted with a piece of rubber tubing compressed with a spring clamp and the other reaching from the cork

to the bottom of the bottle By inverting the bottle the esters rise to the top and the lower layer may be drained off by opening the clamp or without inverting the bottle the lower layer may be syphoned off through the long glass tube

A separating funnel is more convenient for separating and washing esters

(2) *Hot Process* —The esters may be prepared much more rapidly by placing the ingredients in a flask over a water bath arranged to maintain a constant level of water (fig 79) A reflux condenser is fitted into the mouth of the flask The water in the water bath is kept at a temperature sufficient to maintain brisk boiling inside the flask This is continued without stopping for 18 hours when it will be found that esterification is complete Washing of the esters is then carried out as in the cold process The weight of the esters recovered is almost equal to that of the oil used

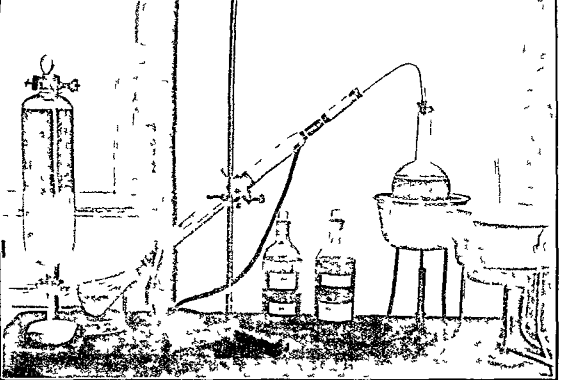


FIG 79
Hot method of making hydnocarpus esters

APPENDIX II

SEDIMENTATION TEST

The technique advised is an adaptation of that used by other workers and is chosen because it makes it possible to test a large number of bloods at once with fair accuracy and with the expenditure of a minimum of time (fig 80)

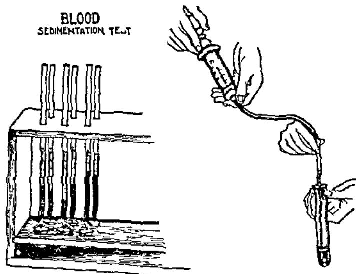


FIG 80

0 3 c c of a 5 per cent solution of sodium citrate in distilled water is drawn into an all glass 2 c c syringe 1 2 c c of blood is drawn from the patient s vein into the same syringe and a small quantity of air having been taken into the syringe barrel the blood and citrate solution are thoroughly mixed by reversing the syringe several times and the mixture is evacuated into a clean test tube If several patients are to be tested their bloods are taken in a similar manner and placed in labelled test tubes in a rack Sedimentation is carried out in 300 mm pipettes graduated

from above downwards from zero to 100 there being a space of 3 mm between each mark.* The capacity of the pipettes when filled up to zero is approximately 1 c c but a variation of 0 05 c c is allowed as such a variation makes no appreciable difference in the results The pipettes are placed upright in a rack with their points inserted in small holes bored in rubber corks (as in the illustration)

One of these pipettes is taken from the rack and its upper end is attached to a 10 c c syringe by means of a rubber tube The point of the pipette is inserted in one of the test tubes and suction being applied by pulling on the piston of the syringe the blood citrate mixture is drawn up into the pipette to the zero mark The pipette is then replaced in the rack the point again being inserted in the rubber cork which prevents the mixture escaping and the rubber tube is then disconnected from the pipette In this way the other pipettes are filled up to the zero mark from the other test tubes The rack with the pipettes should then be placed in an incubator at 37°C if this is available If it is not available incubation at room temperature is sufficiently accurate

The top level of the erythrocytes is read off after 1½ hours and again after 2½ hours and the average of these two readings is taken as the sedimentation index (S I) Thus if the level of the top of the blood cells falls to 10 (30 mm) after 1½ hours and to 20 (60 mm) after 2½ hours the S I will be the average of 10 and 20 i e 15

The maximum reading is about 80 (240 mm) In healthy individuals the S I should be below 10 but in many who are in training it will fall almost to zero

The test has no specific significance in leprosy but it is useful on account of the fact that with few exceptions every disease and other condition which causes a rise of the S I at the same time lowers the resistance of the patient to leprosy Its value is therefore in determining and in seeking for causes which lower resistance

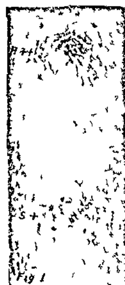
* These tubes can be obtained from [illegible] dia Chemical Works C 44 & 45 Coll ge Street Market Calcutta.

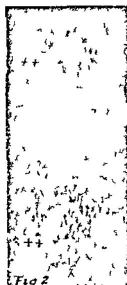
viously being used in place of the lepromatous skin This forms the Stefansky (S) leprolin

It is difficult to standardize leprolin accurately as in neither of the organisms used is an *in vitro* culture yet available For practical purposes however the above technique is sufficiently accurate This is shown by making a series of intradermal tests with full strength standard leprolin and dilutions 1 in 2 1 in 4 1 in 8 While the stronger suspensions give a somewhat stronger reaction the difference in reaction is not in proportion to the difference in dilution 1 in 8 giving a reaction not very much less than full strength For the sake of uniformity however we keep a standard smear of each suspension which has been prepared by spreading out a standard loopful over a given area of slide and the concentration of bacilli compared No attempt at counting the bacilli is made but it is possible to tell whether the numbers are approximately equal By making several such examinations before diluting the suspension it is possible to adjust the strength by adding more or less saline Stefansky leprolin should be standardized so that nodules similar in size are produced by the two leprolins when injected intradermally in the same quantities into healthy non leprous subjects

The thin skin on the inner side of the arm below the axilla is chosen for inoculation the H leprolin being injected about one inch above the S leprolin The usual dose of each is 0 2 c c Care should be taken that injection is made into and not under the skin a wheal should rise round the point of inoculation A slight serous effusion appears after the injection and disappears after a few days In positive cases nodules appear at the sites of inoculation between the first and third week and increase gradually in size up to a maximum

The degree of reaction is read by measuring the size of the nodule in millimeters between the blades of a sliding calipers Readings are made after 14 days and then once a week up to the eighth or tenth week The maximum reading of each nodule is taken as the index The S





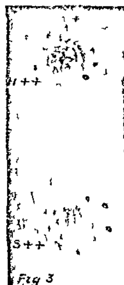






Fig. 8

[illegible]

nodule often forms more rapidly than the H In strong reactions there may be slight *necrosis and liquefaction* at the centre of the nodule (fig 81)

In healthy adults not infected with leprosy both nodules are as a rule approximately equal and of moderate size 6 to 10 mm In resistant cases especially those with neural macules or primary neural lesions the H are as a rule larger than the S nodules In cases of cutaneous leprosy we find the reverse H leprolin giving a negative result or at least a weaker reaction than the S leprolin In young children and in debilitated persons both leprolins tend to give weak or negative results

The leprolin test is thus of use in measuring the special resistance of the patient to leprous infection The most favourable cases are those giving a strong reaction to Hansen s leprolin If the latter gives a negative or weak reading in a patient with only slight clinical signs of leprosy careful and repeated examinations of skin and nose will often reveal foci of bacilli

Stefansky s leprolin forms a useful control but if it is not available the test may be made with Hansen s leprolin alone

APPENDIX IV

Iodide Test

When cutaneous leprosy has reached a stage in which repeated bacteriological examinations of the skin and nasal mucosa give negative results the iodide test is of considerable value *It should only be used however in cases in which the general health is of a high standard and the sedimentation test gives uniformly satisfactory findings* (S I of 10 or less)

A single dose of 30 grains of potassium iodide is given in a glass of water at bed time This may cause one or more of the four following results (*a*) The appearance of new or the reappearance of old cutaneous lesions (*b*) pain tenderness or swelling of nerves (*c*) rise of temperature and other general signs (*d*) increase in the rate of erythrocyte sedimentation

If any of the four above mentioned signs appear the next dose of iodide should be delayed *till they have entirely subsided* Any skin lesions which may appear should be examined for bacilli and if these are found intradermal injections should be given locally until negative results are obtained The same dose of iodide should then be repeated If no signs of reaction appear then increasing doses are given once a fortnight viz 60 90 120 180 240 grains These should always be diluted with two or three glasses of water Any sign of reaction is an indication for not increasing the dose and for delaying the next dose till *all* signs of reaction have disappeared The smaller amounts may produce catarrh and other signs of iodism but these are generally absent when the larger amounts are given If any difficulty is experienced in swallowing a large quantity of iodide at one time then it may be divided into two or three portions taken at half hourly intervals The maxi

mum dose of 240 grains should be repeated three times Iodides tend to produce what may be regarded as a negative phase The precautions mentioned above are intended to secure that administration of the drug is not repeated during this negative phase

N B—Never give the next dose of iodide till the S I has subsided to (or below) 10

APPENDIX V

Temperature Chart

Date					
3 A M					
6 A M					
9 A M					
12 noon					
3 P M					
6 P M					
9 P M					
12 P M					
Stools					
Notes					

APPENDIX VI

CASE CARD

(As used in dispensary at School of Tropical Medicine Calcutta)

FIG 82

Case and treatment card The markings of the second third and fourth page are shown appearing behind the front page The card is double and opens like a book temperature charts and other records being filed between the two halves

APPENDIX VII

A Leprosy Case Progress Chart

According to Drs Wade and le Roux

The essential part of the chart is the form for the progress graph in the accompanying example that form plus space for recording the bacteriological findings occupies one half of the total enclosed space but this can of course be varied to suit particular needs or preferences The other part susceptible to much more variation is provided for the periodical summarization of data such as weight treatment and clinical events which presumably will include the occurrence of lepra reaction and important complicating conditions Where tests such as the sedimentation index or the Wasserman reaction are made periodically separate spaces for them would be provided

The progress form itself has two parts one for the C (cutaneous) and one for the N (neural) phase of the disease and each of these type areas is divided into three spaces in accordance with the sub types of the Memorial Conference classification (C1 C2 and C3 N1 N2 and N3) Each of these spaces is further subdivided the reason for this being that during the intervals between examinations there may be changes in the case sufficient to be indicated in the graph as a trend but not sufficient to change the actual classification from for example C2 to C1 The first least advanced of the sub type spaces (i e C1 and N1) are both nearest a central blank space which may be called the negative or neutral zone so that with increasing severity of the case the graph line goes farther from that zone and in an advancing mixed case the two lines diverge The negative zone is intended to indicate

Clinical Notes	Bacteriology	N	N	N	C	C	C	Month	Year
Infiltration and degree limited ... Pulm ...	+ +							July	1930
								Jan.	1931
As ...								July	
Lepra re ...; ...								Jan. March May Aug. Oct.	1932
Albumen ... urine slight								Jan.	1933
Nephritis Lepr re ... marked DIED, May 31								July Aug. May	

Fig 83

Clinical Notes	Bacteriology	N	N	N	C	C	C	Month	Year
Neural moderate					NEURAL			Feb. Aug.	1929
Lepromatous slight	+							March	1930
	+ +				...			May Aug.	
	+ +							Dec.	
Improving	+							April	1931
(Negati ...)	Neg							Aug.	
...	Neg							Nov.	
...	+ +							Jan.	1932
Improved	+							May	
(...)	Neg							Nov.	
...	Neg.							...	1933
	Neg							May	
	Neg							Aug.	
Paroled	Neg							Nov.	
Re ...	Neg							June	1934

Fig 84

absence of—or rather disappearance of—evidence of the disease

With respect to the vertical rulings the chart may be divided for as many years as desired but the narrower these divisions are made the fewer notes can be inserted in them Each of the year spaces is subdivided as if for quarterly recording not because it is expected that many will attempt to reclassify their cases so frequently but in order to permit rough correlation of records and dates as shown in the illustrative cases

The sample chart herewith is designed for a sheet form measuring 8×10 5 inches the left hand margin being wider to provide for binding but it can easily be modified for other sizes of records A modification based on suggestions received is printed on an ordinary 8×5 inches filing card one half of the whole form on each side Better in certain respects would be to use a double card of tough durable stock 8×10 inches when opened folding transversely and then measuring 8×5 inches to be filed of course with the folded edge uppermost The entire chart could be printed on the inside the outside back and front would be available for other records including personal data

APPENDIX VIII

VILLAGE CARD

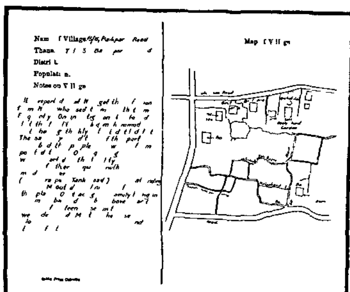


FIG 85a
Front of village card

Serl 1 N mber	am	H gd N mbe	Ag	Sex	Caste	T pe	D m	Remar
	mudd			M	M.J		y	t inf from Mo
2	b							
3	ff				d			ose Sege
	5				d		10	
	ah							
	p	Bhagalpur		M	M thar		yet	
	ha							
	bh al						math	
	al	d			d		y	
10	ul	d		M	d			
	ar	d		M	d		math	
	/ 2	r	m	ced	me k l			
	Gele kamar	C Bars de		M	mar		yr	
	h				d	N	amonth	
	/53	D	um	aed	same house			
	/	Dumk	22	M	M thar		rs	
	am math	Ban		M	d		math	
	M la	Bhagalpur	35	M	do		yr	
	b	do		M	d	N	rs	orpn weeper 52

D tes of Visits	I tial.	tes f	I al.	D te Visits	I tial.

FIG 85b
Back of villag car l

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